
Guidance for Assessing Indirect and Cumulative Impacts of Transportation Projects in North Carolina

Volume II: Practitioner's Handbook

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EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

The North Carolina Department of Transportation (NCDOT), in consultation with the North Carolina Department of Environment and Natural Resources (NCDENR), undertook to develop a guidance document, or policy, for evaluating the indirect and cumulative effects of transportation projects in January 1999. The assessment of indirect and cumulative effects is identified as a requirement under the National Environmental Policy Act of 1969, as amended (NEPA), the North Carolina Environmental Policy Act (SEPA), and under the Council on Environmental Quality (CEQ) regulations implementing NEPA. However, there are limited standardized and comprehensive rules, legislation, procedures or guidance available for implementing these requirements. Compounding this shortcoming is the apparent confusion regarding basic definitions and terms, such as the extent of corporal and temporal boundaries in determining these effects. These problems have hindered the assessment of indirect and cumulative effects in environmental impact statements throughout the country.

The purpose of this guidance is to provide NCDOT NEPA/SEPA practitioners with a tool to help in the identification, analysis and assessment of indirect and cumulative effects of transportation projects as part of the NEPA/SEPA assessment process. This guidance is also intended to help federal and state environmental regulatory and resource agencies, such as NCDENR, to understand the assessment of indirect and cumulative effects and to provide a “standard” for reviewing NEPA/SEPA assessment documents. Specifically, this guidance is intended to meet the following objectives:

- < Describe the terminology related specifically to indirect and cumulative effects assessment as defined by regulations and clarified by the courts.
- < Apply the existing case law regarding indirect and cumulative effects assessment to interpretations of terms and applicable practices under NEPA/SEPA.
- < Provide direction on project scoping issues and their implications for addressing indirect and cumulative effects.
- < Provide direction on identification and evaluation of project-induced growth effects.
- < Describe various methodologies and techniques, which may be considered when undertaking indirect and cumulative effects assessment.
- < Describe a framework for incorporating in indirect and cumulative effects in NEPA/SEPA documents, e.g., environmental assessments or environmental impact statements, as well as in the planning and other activities, which precede the documents.

This volume, Volume II: Practitioner's Handbook, describes the “how-to” methods of indirect/cumulative impact assessment. Volume I: Guidance Policy Report, comprises the technical, memoranda prepared for the agencies' review in developing the guidance.

SECTION I
HOW THIS HANDBOOK IS ORGANIZED

SECTION I

HOW THIS HANDBOOK IS ORGANIZED

This Handbook presents a Framework and supporting methods suggested for indirect/cumulative impact assessment. The steps of the Framework generally conform with conventional impact assessment approaches. However, as with many assessments, there are a variety of tools and techniques that may be employed to suit the project-specific circumstances. Accordingly, checklists and flowcharts have been provided at each step to guide the organization and assessment of data. Use of these tools is recommended but not required.

Application of the Framework is not appropriate or necessary for all transportation projects. Section II of the Handbook describes thresholds to sort projects into those for which the indirect/cumulative impact assessment is normally warranted and those for which it is not. Practitioners are advised, however, that even though an indirect/cumulative impact assessment may not appear to be warranted for a particular project based on the thresholds, project-specific circumstances may dictate otherwise. Therefore, it is suggested that involved parties be consulted, as appropriate, before determining that an assessment is not necessary, and that the reasons supporting that conclusion be fully documented in the environmental documentation for the project.

The Framework consists of eight steps organized into three main groupings:

- < Section III - Developing the Scope of the Indirect/Cumulative Impact Assessment
- < Section IV - Analysis of Indirect/Cumulative Effects
- < Section V - Assessing the Consequences

Indirect/cumulative impact assessment typically cuts across many disciplines. It is recommended that a multidisciplinary approach be used when applying the Framework.

SECTION II
PRE-SCREENING PROJECTS FOR APPLYING
INDIRECT/CUMULATIVE IMPACT ASSESSMENT

SECTION II

PRE-SCREENING PROJECTS FOR APPLYING INDIRECT/CUMULATIVE IMPACT ASSESSMENT

Not all proposed transportation projects will cause measurable indirect effects or contribute to measurable cumulative effects. In light of effective utilization of agency resources, it is appropriate that transportation projects be subject to a level of analysis that is commensurate with the potential magnitude and importance of potential indirect/cumulative effects attributable to the project.

Can proposed transportation projects be pre-screened (or sorted) into those which should be evaluated through application of the indirect/cumulative impact assessment framework versus those for which application of the framework is not normally warranted? The answer to this question depends in large part on the type of indirect/cumulative impact in question.

It is difficult to apply a general pre-screening threshold for those indirect/cumulative effects on resources that are solely linked to the project “foot print” (e.g., limits of disturbance) rather than linked to transportation system access alterations and associated changes in land use. Whether or not to apply the indirect/cumulative impact assessment framework in such cases will often depend on whether there is potential for effects on resources subject to Federal or North Carolina statutes. If there is no such potential, then evaluation of the project under the indirect/cumulative impact assessment framework will normally not be warranted. If there is such potential, then the indirect/cumulative effects should generally be considered in conjunction with the direct effects under the pertinent resource heading(s) in the environmental document and, if applicable, as part of the permit application(s).

Generally, for a transportation project to cause changes in accessibility that lead to land use changes and changes in travel patterns (and concomitant impacts on resources), the project needs to be located on a particular type of transportation facility. It is generally accepted, e.g., for purposes of transportation conformity, that such “regionally significant” projects are normally located on facilities classified as principal arterials or above (and equivalent transit facilities). These projects can be identified by completing the project data sheet Figure II-1.

Transportation improvements on such facilities that can lead to changes in land use are listed on Figure II-2. Under most circumstances, evaluation of the types of indirect/cumulative effects linked to alteration in transportation system access and related changes will not be warranted when the project is on a facility that does not serve the functions of, or is of lesser magnitude than those listed in Figure II-2.

FIGURE II-1 CHARACTERIZATION OF NEW HIGHWAY CONSTRUCTION

1. Type of new construction:

- | | | | |
|----------------------------------|-----------|----------|-----------------|
| a. Bypass: | _____ yes | _____ no | |
| b. Connector Road: | _____ yes | _____ no | |
| c. Roadway Relocation: | _____ yes | _____ no | |
| d. New Highway Construction: | _____ yes | _____ no | |
| e. New Interchange Construction: | _____ yes | _____ no | |
| f. Others: | _____ yes | _____ no | describe: _____ |

Please answer questions 2 and 3 relating to current conditions on the primary existing route. If a model is used, please provide node numbers.

2. Road Section Description

- a. Name (SR Route): _____
- b. From: _____ Node # _____
- c. To: _____ Node # _____
- d. Segment Length: _____
- e. Function Class (Check one):
- | | | |
|----------------------|-----------------------|-----------------------|
| ___ Rural Interstate | ___ Other Princ. Art. | ___ Minor Art. |
| ___ Major Collector | ___ Minor Collector | ___ Local |
| ___ Urban Interstate | ___ Other Freeway | ___ Other Princ. Art. |
| ___ Minor Art. | ___ Major Collector | ___ Local |
- f. Area Type (check one) ___ Rural ___ Small Urban ___ Urban

3. Traffic Data:

- a. Annual Average Daily Traffic (AADT) Volume: _____ veh/day
The above traffic count is (check one): ___ One-way ___ Two-way
- b. Average Daily Weekday Traffic (ADWT) in July: _____ veh/day
- c. The above traffic count is (check one): ___ One-way ___ Two-way

Please answer questions 4 and 5 concerning the new location. If a model is used, please provide node numbers.

4. New Road Description:

- a. Name (SR Route): _____
- b. From: _____ Node # _____
- c. To: _____ Node # _____
- d. Segment Length: _____
- e. Function Class (Check one):
 - ___ Rural Interstate ___ Other Princ. Art. ___ Minor Art.
 - ___ Major Collector ___ Minor Collector ___ Local
 - ___ Urban Interstate ___ Other Freeway ___ Other Princ. Art.
 - ___ Minor Art. ___ Major Collector ___ Local
- f. Area Type (check one) ___ Rural ___ Small Urban ___ Urban

5. Traffic Forecast (not needed for model):

- a. New alignment volume: Estimated average daily traffic: _____ veh/day
The above traffic estimate is (check one): ___ One-way ___ Two-way
- b. Estimated Peak Hour Diversion from Parallel Facilities:
 - i. From Freeways:
 - From Street: _____ Volume (vph) _____
 - To Street: _____
 - From Street: _____ Volume (vph) _____
 - To Street: _____
 - From Street: _____ Volume (vph) _____
 - To Street: _____

ii. From Arterials:

From Street: _____ Volume (vph) _____

To Street: _____

From Street: _____ Volume (vph) _____

To Street: _____

From Street: _____ Volume (vph) _____

To Street: _____

iii. From Locals:

From Street: _____ Volume (vph) _____

To Street: _____

From Street: _____ Volume (vph) _____

To Street: _____

From Street: _____ Volume (vph) _____

To Street: _____

FIGURE II-2

**MINIMUM PROJECT-LEVEL PRE-SCREENING THRESHOLDS FOR
INDIRECT/CUMULATIVE EFFECTS LINKED TO TRANSPORTATION SYSTEM
ACCESS CHANGES**

- 1) Highway/Roadway
 - a) New construction or new location of Principal Arterial or above, one mile or longer;
 - b) Widening of Principal Arterial or above to provide additional through-traffic lanes, one mile or longer (urban) or 2.5 miles or longer (rural); and
 - c) Additional grade-separated ramps or new interchanges on Principal Arterials or above.
- 2) Transit/Rail
 - d) New passenger rail service and extensions of existing service, 5 miles or longer;
 - e) Purchase of additional (not replacement) rolling stock to support increased frequency and higher ridership;
 - f) Rail connections to provide new regional service; and
 - g) New rail stations and new or expanded rail park-and-ride facilities resulting in 100 new parking spaces.

SECTION III
DEVELOPING THE SCOPE OF THE
INDIRECT/CUMULATIVE IMPACT ASSESSMENT

SECTION III

DEVELOPING THE SCOPE OF THE INDIRECT/CUMULATIVE IMPACT ASSESSMENT

Scope development is the key to proper and timely identification and analysis of indirect/cumulative effects. Whether accomplished through formal scoping at the onset of EIS preparation or otherwise, scope development provides the best opportunity to identify potentially significant issues, set appropriate boundaries for the analysis, and identify relevant past, present and future actions. Scoping also allows for the setting of the environmental baseline to which all effects are compared.

Under the federal Council on Environmental Quality (CEQ) regulations (40 CFR 1500-1508), specific details regarding scoping are provided at § 1501.7. As part of this scoping the lead agency should:

- < “determine the scope and significant issues to be analyzed in depth in the Environmental Impact Statement.” (§ 1501.7(a)(2));
- < “identify and eliminate from detailed study the issues which are not significant or which have been covered by prior environmental review” (§ 1506.3); and
- < narrow “the discussions of these issues in the statement to a brief presentation of why they will not have a significant effect on the human environment or providing a reference to their coverage elsewhere.” (§ 1501.7(a)(3)). These issues include those that have indirect and cumulative effects as well as direct effects.

The scope of the indirect/cumulative impact assessment should generally identify social, cultural and natural (physical and ecological) resource issues that effect the human environment; and identify potentially significant issues and effects for further analysis. Full identification and consideration of these issues involves working through the following steps of the framework as part of scope development.

- < Step 1 - Define the Study Area Boundaries;
- < Step 2 - Identify the Study Area's Direction and Goals;
- < Step 3 - Inventory Notable Features;
- < Step 4 - Identify Impact Causing Activities of the Proposed Action and Alternatives; and

< Step 5 - Identify Potential Indirect/Cumulative Effects For Analysis.

These steps and the methodologies appropriate for carrying them out are described in detail in Chapters 1 through 5 that follow.

Chapter 1

Step 1 - Defining the Study Area Boundaries

Overview

When estimating the direct effects of a proposed project, study areas are often delineated using a set distance, e.g., from the centerline or right-of-way limits. Since indirect/cumulative effects can occur at a distance in time or space from the proposed project, broader limits, often not a uniform distance from the proposed project, must be set. Techniques for determining study areas fall into several general categories:

- < political/geographic;
- < commuteshed;
- < growth boundary/service area;
- < watershed/habitat; and
- < interview/public involvement.

In most analyses, these categories are combined to create a study area that will encompass all potential indirect and cumulative effects relevant to an action. It can also be expected that study area boundaries may be adjusted in the course of a study as resource areas and potential effects are identified with more specificity.

This chapter will:

- < describe the basic techniques for setting study area boundaries;
- < discuss the considerations for setting the timeframe for evaluation of indirect/cumulative effects; and
- < outline how study area techniques may be combined to ensure a comprehensive evaluation.

Boundary -Setting Techniques

There are several techniques to choose from when setting the physical boundaries of the study area. The techniques and considerations for their implementation are detailed below. In general, study areas should encompass the project or plan alternatives in their entirety and also include the surrounding physical, social, and natural resources that could be expected to be impacted by the project or plan.

Political/Geographic Boundaries

Study area boundaries based on the limits of political jurisdictions or geographic features often work to facilitate analysis for the following reasons:

- < many existing data sources such as demographics, growth projections, comprehensive plans, and resource inventories are delineated by political jurisdictions;
- < stakeholders and the public can easily understand familiar political or geographic boundaries; and
- < land use regulations and other measures to control growth are enacted on the county or municipal level.

Examples of political or geographic boundaries include:

- < counties
- < minor civil divisions (municipalities)
- < tribal lands
- < planning districts
- < special improvement districts and enterprise zones
- < census tracts or block groups
- < traffic analysis zones or aggregations of zones
- < rivers, water bodies, mountain ranges

While using political or geographic boundaries can make the task of data gathering and the presentation of findings easier, care should be taken to avoid the following errors:

- < *Undersized study area* - Dividing lines between political jurisdictions are often arbitrary and do not reflect present or future trends in development. Similarly, habitat areas or areas of social cohesion may cross these dividing lines. For this reason, this method may be most appropriate after an examination of community characteristics, commute patterns, growth trends, or habitat locations using the methods below. The study area can then be increased in size to match the boundaries of a political jurisdiction or group of jurisdictions that encompass important features. The choice of a study area along political or geographic boundaries should always be done so as to increase the size of the study area.
- < *Oversized study area* - While an oversized study area is preferable to a smaller one, a larger study area will require a greater commitment to data gathering and analysis. A larger study area also may increase the threshold for consideration of when environmental features can be considered notable. This may cause impacts on smaller community or habitat features to be overlooked.

Commuteshed

Effects related to project-induced development are dependent upon changes in accessibility. Projects that have the potential to substantially alter travel times to major regional demand generators may make an area more attractive to growth and development. To fully account for this effect, a study area should be sized to coincide with a set commuting range or travel time to a major destination. Destinations should be of a size and type sufficient to affect the locational choices of future residents or employers and include city centers, or major regional employment centers such as office or industrial parks, or suburban commercial centers.

Commuteshed boundaries can be determined through several techniques:

- < *Census data* can be used to set the commuting time threshold. For example, most commutes in many parts of the nation are 20 to 30 minutes in duration. The journey-to-work questions on the Decennial Census provide information on the range of commute times in a county, municipality or census tract by mode of transportation. The Census Transportation Planning package available from the Bureau of Transportation Statistics (U.S. DOT) provides characteristics of workers, of persons, workers, and housing units at the traffic analysis zone (TAZ) level. For projects of regional significance or transportation systems planning, journey-to-work county flow files available at the Census internet site show county of origin by place of work or county of employment by place of residence.
- < *Origin and destination surveys* conducted by a regional planning agency, or for study of the need for proposed project or other projects in the study area can be used to delineate a study area by grouping together the most frequent pairings of origins and destinations.

- < *Travel demand model output* can also be used to delineate a study area based on flows between TAZs.

When using the commute threshold technique, the study area should, whenever possible, take the travel time savings of the project alternatives into account. This can be accomplished by setting the study area to coincide with the area accessible under the alternative that provides the greatest time savings. Similarly, output from a travel demand model of the alternative with the most time savings would be appropriate. Origin and destination surveys are not dynamic and, therefore, may not be practical in situations where there is a great difference in travel time between the no-build and build scenarios.

Growth Boundaries/Service Area Limits

Jurisdictions with growth management policies, areas planned for development, or areas expected to see growth in population or employment may already be delineated in long-range infrastructure (sewer/water districts) or growth management plans. In some cases development beyond this area, or the extension of infrastructure to serve it, is limited or restricted. In these circumstances it may be appropriate to confine consideration of indirect/cumulative effects to a study area coincident with accepted growth boundaries. When doing so, efforts should be made to evaluate the effectiveness or strength of the growth regulations to confirm that development beyond the proscribed area is indeed unlikely. It should also be confirmed that no encroachment alteration effects arising from the project could occur outside this growth boundary study area.

Watershed/Habitat

Encroachment-alteration effects arising from a project or project-induced growth may have immediate effects on a watershed or habitat that give rise to broader ecosystem, water quality, or water quantity issues. To anticipate the full range of effects, it may be appropriate to size the study area to match the extent of potentially impacted watersheds or habitat features. This can be accomplished through a baseline screening of notable features of the natural environment (Chapter 3).

Interview/Public Involvement

Stakeholder interviews, expert panel techniques, task forces, or other public involvement efforts can be utilized to define a study area, or approve or refine a study area created with any of the techniques described here. The general approach is to query experts or stakeholders about the geographic extent of potential effects or test the validity of findings derived from another technique.

Timeframe Considerations

Since indirect/cumulative effects can be distant from the project in both time and space, setting a time horizon for the analysis is another goal of scoping. The time frame should be short enough in duration to anticipate reasonably foreseeable events, but should be long enough in duration to capture the development and relocation effects that may only transpire over the course of several business cycles. Most indirect/cumulative effects study set a time horizon equal to the design life of a project, usually twenty to twenty-five years. This is also the time horizon used in most MPO and county level planning forecasts.

Combining Study Area Tools

Because each of the study area techniques described above are related to particular types of physical, natural, or social resources, it is often necessary to combine the techniques to produce a study area suitable for consideration of the full range of potential indirect/cumulative effects. An illustration of boundary technique combination appears in Figure III-1 and an example is as follows:

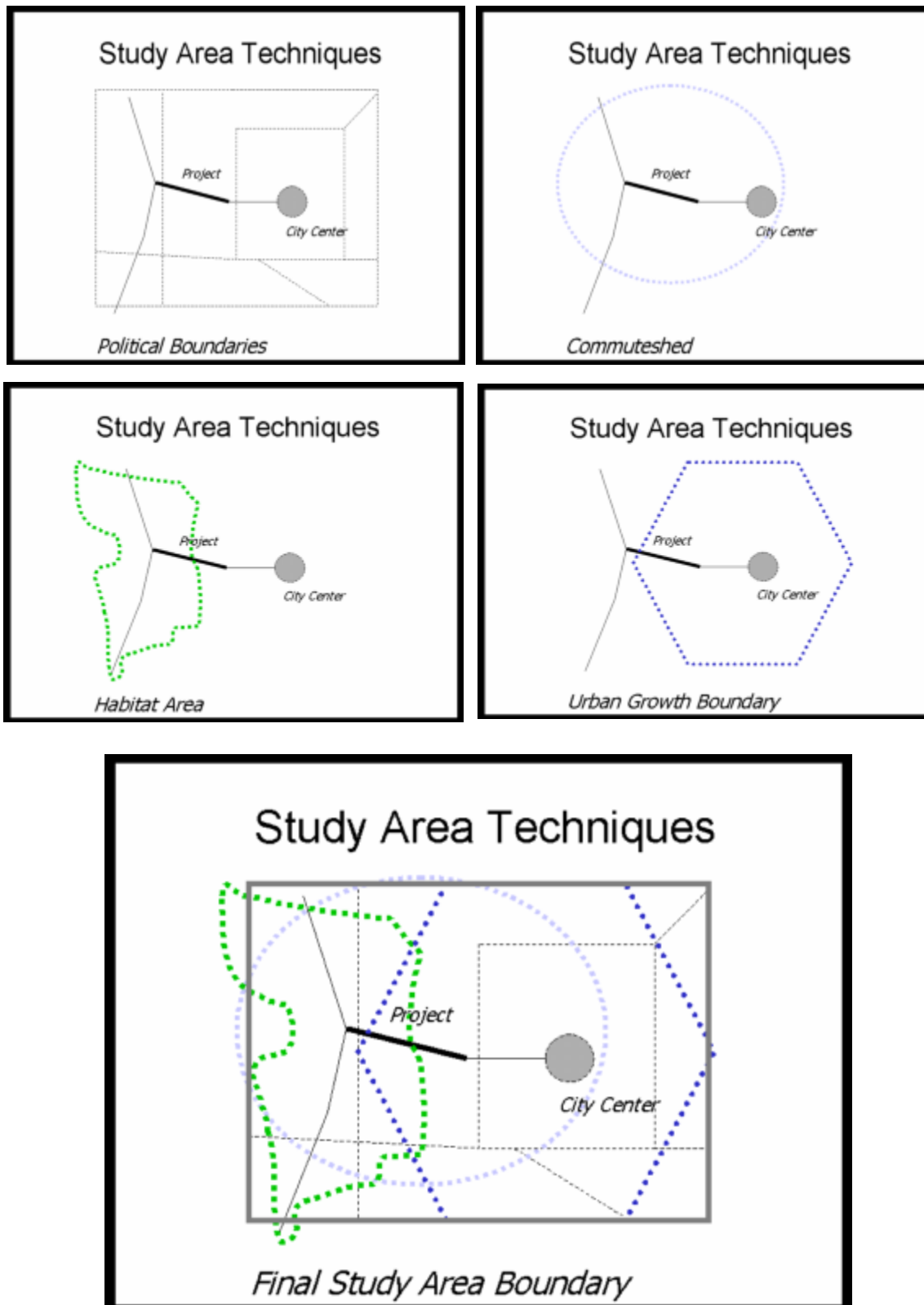
- < A commuteshed or growth boundary technique could be utilized to define the area for consideration of induced growth effects.
- < A habitat or watershed approach could be added to ensure consideration of encroachment-alteration effects or environmental effects related to induced growth.
- < To facilitate data gathering, the size of this combined study area may be increased to encompass an entire political or data unit or groupings of those units, for example counties, municipalities, or groupings of TAZs.
- < The delineated study area and the methods used could then be presented to stakeholders and other interested parties to seek their concurrence.

Recognizing that some techniques will not be appropriate in every situation, the analyst should choose a technique or set of techniques that best fit the resources, potential effects, and data available in a particular area. Choice of a study area and the techniques used to establish it should be well documented, and it should be recognized that it may be necessary to change study area boundaries if new information regarding resources or potential effects is revealed during the remainder of the scoping process.

Work Product of Step 1

The work product of the study area delineation effort should be a map delineating the study area boundaries accompanied by brief technical memorandum describing the methods employed in the determination.

Figure III-1: Combining Study Area Techniques



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Chapter 2

Step 2 - Identify the Study Area's Directions and Goals

Overview

After delineation of the study area is complete, it becomes important to begin to gather a wide range of data describing baseline conditions in study area. This second step in the indirect/cumulative effects assessment framework will focus on assembling information regarding general trends and goals within the study area. The trends and goals in question are independent of the proposed transportation project and typically concern social, health, economic, ecological, and/or growth-related issues.

Empirical evidence indicates that transportation investments result in major land use changes only in the presence of other factors. These factors include:

- < supportive local land use policies;
- < local development incentives;
- < availability of developable land; and
- < a good investment climate.

An understanding, therefore, of community goals, combined with a thorough knowledge of demographic, economic, social, and ecological trends is essential in understanding the dynamic of project induced growth. Later in the process, it will also be important to compare study area goals with potential impacts. Conflict between impacts and goals is a key determinant of impact significance and an indicator of effects that merit further analysis. Knowledge of goals and trends will also facilitate an evaluation of project alternatives and the formulation of strategies to meet all community and regional goals.

There are a variety of considerations related to identification of study area trends and goals. This chapter will provide practitioners with an overview of these considerations and will:

- < outline the types of goals and trends relevant to this step;
- < highlight potential sources of information;
- < describe techniques for data gathering and public involvement; and

- < provide checklists useful for applying this step in practice.

Considerations

Timing

Ideally, this step should be timed to coincide with the process of problem identification and needs assessment (deficiencies analysis), which is often the first step in the transportation planning and development process. Conducting this step during the earliest part of the planning process for transportation systems or projects will help to ensure that the social, economic, and environmental goals of communities in the study areas will be evaluated in tandem with their transportation needs in formulating proposals for transportation projects. It will also facilitate a streamlined NEPA/SEPA process, promote the minimization of conflict between project effects and study area goals, and work to reduce the need for mitigation and enhancement efforts after the project is designed.

Because trends and goals are subject to change over time, and the length of time between the planning process and NEPA/SEPA evaluation can be lengthy, it will be important to reevaluate the currency of any data throughout the NEPA/SEPA process.

Analysts beginning the process of indirect/cumulative effects analysis after the project is designed should make every effort to utilize information developed previously to assess project purpose and need. Evaluations conducted for statewide planning purposes or transportation plans developed by MPOs may also be useful.

Social, economic, and environmental goals expressed through formal plans reflect a current vision of the future. Because of their inherent rippling effect over space and time, one way to measure a transportation system's or project's indirect/cumulative effects is to envision the future both with and without the system or project improvements. Consideration of various goals early in the planning process can help focus the effort toward balancing transportation and other needs, and also toward understanding potential indirect and cumulative effects.

Data Collection

Goals are typically spelled out in plans or policies. The content of available plans is typically examined during the transportation project development process. For example, such plans can provide future population and employment growth and land development information for the study area. Further, the NEPA regulations (40 CFR 1508 and 23 CFR 771) require an evaluation of project consistency with local plans. The literature indicates that better understanding of the interrelationships between an area's transportation and other goals early in the process can lead to better anticipation of a proposed transportation project's indirect/cumulative effects issues,

e.g., a balance between conflicting needs and goals. However, this does not mean that conflicts over indirect/cumulative effects will necessarily be avoided by considering non-transportation goals in the process.

The CEQ has outlined general goals (eleven principles) of ecosystem (biodiversity) management (Figure III-2). CEQ suggests that these goals be considered by Federal agencies when assessing the effects (direct, indirect, and cumulative) of their actions, including actions at the project-specific or site-specific level. These goals are expressed through a number of Federal, state, and local resource management plans (e.g., those for the North Carolina coastal area and various river basins).

Relative to ecological goals, social or economic goals are typically not as well formulated or articulated at this time, both generally and at the local level, e.g., in comprehensive or growth management plans. While general principles of social impact assessment are being advanced, goals are typically expressed in very broad terms, e.g., maintain community character or manage growth, and will vary with location.

Proposed transportation improvements are often planned to support an area's economic development goals. The desired economic growth is seen to be dependent upon the accessibility improvements and increase in location attractiveness that the transportation project will bring. In these cases, the plans demonstrate that development is "caused by the action" and is "reasonably foreseeable," therefore the land use conversion and environmental effects associated with that growth should be treated as indirect effects of the transportation project. Understanding the economic development goals of communities in the study area should not only help formulate the scope of the proposed transportation improvement, but will also help analysts understand the nature of the induced indirect/cumulative effects.

While it is recommended that available plans be used to help determine the area's various goals, several items should be kept in mind:

- < *Age of the Plan* - In many areas there is no requirement for periodic updating of comprehensive plans even where there is a formal planning process. Political winds tend to change over time and a dated plan may not reflect the area's current needs and goals.
- < *Geographic Coverage of the Plan* - Often, an incorporated area may have a comprehensive plan and zoning while an adjoining unincorporated area does not. The distinction between the incorporated and unincorporated area in terms of current land use may not be clear. However, the absence of land use controls in the unincorporated area may affect the character of future urbanization in the incorporated area. In addition, one municipality's growth management plan may not conform to the overall plan for a region.

- *Plan Preparers* - It is important to know who was involved in plan preparation. For example, whether or not the local citizenry has bought into a resources management plan prepared by a non-local entity.
- *Importance Ascribed to Plan* - The degree of importance attached to the goals by the public and their decision-making authorities is important in determining any potential conflict between goals and impacts and in gauging the likelihood of plan enforcement or change in the future.

Even in areas where there is an up-to-date plan and an effective planning process, it is probably wise to use a public involvement method or methods to at least confirm the directions and goals expressed in the plan, plus to gather information on the area's directions and goals first hand, when appropriate. Moreover, certain methods can be used to flesh out alternative scenarios in more detail than expressed in a plan. This greater level of detail may be needed for subsequent indirect/cumulative effects assessment if issues are anticipated. Accordingly, the methods discussion evaluates appropriate public involvement techniques for this step.

FIGURE III-2

CEQ GOALS FOR ECOSYSTEM (BIODIVERSITY) MANAGEMENT

1. Take a “big picture” or ecosystem view;
2. Protect communities and ecosystems;
3. Minimize fragmentation, promote the natural pattern and connectivity of habitat;
4. Promote native species, avoid introducing non-native species;
5. Protect rare and ecologically important species;
6. Protect unique or sensitive environments;
7. Maintain or mimic natural ecosystem processes;
8. Maintain or mimic naturally occurring structural diversity;
9. Protect genetic diversity;
10. Restore ecosystems, communities and species; and
11. Monitor for biodiversity impacts, acknowledge uncertainty, and be flexible.

Source: CEQ, *Incorporating Biodiversity Considerations into Environmental Impact Analysis Under the National Environmental Policy Act*, January 1993.

The area's expressed goals give a part of the picture needed to understand potential indirect/cumulative effects in a "big picture" context. It is also important to understand direction, i.e., where an area has been, where it is, and where it is going. Direction can be understood in part by identifying past, present, and anticipated socioeconomic, environmental quality, and land development trends. Equally important is knowing the forces that have shaped landscapes, economic activity, and land use patterns, e.g., transportation system, physical environment, political, and market influences, and how the forces were influential (the same is true of existing and anticipated forces).

Methods

Step 2A - Data Collection

The data collection task for this step should generally rely on readily attainable sources. The data collection should not be viewed as an end in and of itself, but rather as a foundation for future steps. Data for this purpose can be both quantitative and qualitative. Figure III-3 describes potential sources of data regarding plans and trends. The checklists provided in Figures III-4 and III-5 are for use in identifying, organizing, and documenting directions and goals.

There are three general sources of data to be considered for this step:

- < *Local/Regional Trend Data* - Recent and historical demographic data available from the U.S. Census Bureau can be assembled in time series and used to identify trends in population and household growth, location, and composition. Official projections generated by state, regional, or MPO agencies should also be utilized whenever possible as a source of information on future conditions. Profiles on trends in industry and the regional economy can be generated from Census Bureau data (*County Business Patterns*) or other government sources (Bureau of Economic Affairs). Data from local authorities regarding annual building permit statistics and zoning variances or changes may also be useful in identifying development trends.
- < *Land Use Plans/Comprehensive Plans* - A variety of public and private entities may be responsible for generating plans reflecting land use and community goals in the study area. The full range of local and regional master plans, park and open space plans, infrastructure plans, and economic development agency documents should be compiled and carefully examined to gather information on the economic, social, and land use goals of communities in the study area.

- < *Local/Regional Development Regulations* - Development regulations currently in force in the study area can be useful in determining community goals and isolating potential areas of conflict as project impacts are identified. Zoning ordinances, special district regulations, and development incentives/disincentives should be examined carefully. Maps of the development regulation boundaries, especially digitized shapefiles for use in GIS, may be useful in other aspects of indirect/cumulative effects analysis.

**FIGURE III-3
DESCRIPTION OF DATA SOURCES
FOR IDENTIFICATION OF GOALS AND TRENDS**

Local Regional Trend Data	
U.S. Census Data	Recent and historical data on population and household growth, race and ethnicity, income, age, and other important factors can be obtained from the U.S. Census Bureau and assembled in time-series for tracts, block groups, or other geographic areas making up the study area to reveal trends.
State/Regional Growth Forecasts	State planning agencies, MPOs or other regional planning authorities are often responsible for generating 20-year growth forecasts for areas under their jurisdiction. Official forecasts of this type should be utilized whenever possible.
County Business Patterns	Data and analysis on industry and economic trends assembled for counties and groups of counties are available through the U.S. Census Bureau.
BEA Industry Data	The U.S. Bureau of Economic Analysis (Department of Commerce), maintains time-series data on industry earnings and employment at the county or MSA level. This data can reveal important trends regarding the character of economic development in the study area.
County/Local Building Permit Data	Yearly data on issuance of building permits or certificates of occupancy can be obtained from county or local authorities to reveal trends on household growth and location.
Variance/Zoning Change History	Public records of county or local authorities with responsibility for granting zoning variances or adopting changes to zoning regulations can be consulted to identify trends in the enforcement and stability of land use regulations.
Land Use Plans/Comprehensive Plans	
State and Regional Land Use Plans	In some jurisdictions, state or regional authorities develop general land use plans containing recommendations or regulations on conservation areas and areas for residential, commercial, and industrial development.
County/Local Building Permit Data	In some jurisdictions, county agencies are responsible for land use plans for the county as a whole or unincorporated areas. The plan may identify goals and objectives for the future physical development of the county with respect to public and private uses of land or other natural resources with an aim of enhancement of physical and economic conditions.
Local Land Use and Master Plans	Where local land use and master planning is conducted, plans should be examined for descriptions of goals and anticipated future conditions.

Federal, Tribal, or State-owned Property Master Plans	Where study areas contain federal or state owned lands, care should be taken to examine plans for the use and expansion of parks, wildlife areas, refuges, forests, and prisons. Development plans for tribal areas are also important.
Park and Open Space Plans	Counties, towns, and cities, may make plans for parks and other open spaces and the management of this land for public enjoyment. The plan can serve to refine and detail the park and environmental corridor preservation recommendations set forth in state or regional plans.
Farmland Preservation Plans	In some jurisdictions, special plans regarding development and conservation of farmland areas have been enacted.
Sewer/Water Service Area Plans	In some jurisdictions, special plans have been developed to guide future expansion of sewer and water utility services. Provision of these services is often directly correlated with the potential for higher density development.
Studies Done by Regional Planning Commissions	MPOs or regional planning commission may have conducted studies or may maintain databases of information regarding land use plans, regulations, and trends.
Local Area Development/Redevelopment Plans	In many jurisdictions, municipalities are authorized to prepare redevelopment plans for areas that substandard or unsanitary as a result of inadequate planning, excessive land coverage, lack of proper light, air, and open space, or other problems of age, or physical deterioration.
Economic Development Agency Plans	Relevant state, regional, or local economic development agencies should be consulted for information regarding areas targeted for development, future development incentives or other plans.
Economic Development Agency Plans	Relevant state, regional, or local economic development agencies should be consulted for information regarding areas targeted for development, future development incentives or other plans.
Private Sector Plans	Large private-sector land holders, such as corporations, developers, private universities, or nature conservancies, may produce plans for the development or management of their land holdings.
Transportation Corridor Plans	An integrated transportation and land use plan may have been prepared for other critical transportation corridors in the study area that have high development potential.
Other Environmental Documentation	Environmental documentation conducted recently for other facilities or projects within the study area may be consulted for data or leads for data sources.
Local /Regional Development Regulations	
County/Local Zoning Ordinances	Zoning is an exercise of government power that regulates and restricts the use of private property in the public interest. Data on zoning area boundaries and regulations are important for determination of goals and application of further analysis techniques.

Official Maps	Official maps illustrate government boundaries, zoning districts, government lands, and street and highway facilities. Maps, particularly those in digital form, are useful for overlay analysis techniques.
Growth Boundaries	In jurisdictions that have enacted urban growth boundaries, it is important to obtain detailed information regarding boundary locations, regulations, and future plans.
Annexation/Extraterritorial Zoning	In jurisdictions where incorporated areas are allowed to exercise zoning authority or annex areas outside their boundaries, information should be gathered on regulations and future plans.
Coastal Regulations	Development and use of coastal areas, floodplains, and wetlands are often regulated by special statutes.
Local Highway Access Controls	Access controls on local roadways within the study area but outside the project area such as curb-cut regulations or arterial access controls are relevant in analysis of goals and future development potential
Special Development Districts	Some jurisdictions may have special districts that regulate development. Examples include urban redevelopment areas, business improvement districts, planned unit development districts, tax increment finance districts, and historic preservation districts.
TDR Sending/Receiving Zones	Some jurisdictions have enacted regulations regarding the transfer of development rights from restricted properties to properties where development is encouraged.
Inclusionary Housing Incentives	Some jurisdictions have enacted regulations and incentives to encourage the development of low-income housing.
Easements and Deed Restrictions	Easements and deed restrictions may determine the future developability of a land parcel. Conservation easements, restricting future development regardless of ownership, have been used recently with more frequency.
Development Moratoria	As part of the zoning authority in some jurisdictions, municipalities or counties may declare a moratorium on development for a fixed or limited time to allow for the completion of infrastructure or land use regulations.
Impact Fees	Some jurisdictions have imposed impact fees on developers to pay for government capital costs necessary to serve development.

Adapted in part from: *Indirect and Cumulative Effects Analysis for Project-Induced Land Development*, Wisconsin Department of Transportation, 1996

FIGURE III-4 ORGANIZATION AND TABULATION OF GOALS CHART

(Check where applicable)

Project Name: _____ Location: _____ Analyst: _____ Date: _____

<u>Social Health and Well-Being Goals</u>	<u>Notes</u>
___ Achieve adequate, appropriate and accessible open space and recreation	
___ Comply with state and federal water and air quality laws	_____
___ Preserve or create multicultural diversity	_____
___ Preserve heritage	_____
___ Provide choice of affordable residential locations	_____
___ Provide urban environment for those with special needs	_____
___ Promote land use patterns with sense of community	_____
___ Provide a range of services accessible to all	_____
___ Promote a healthy and safe environment	_____
___ Provide sound management of solid and hazardous waste	_____
___ Other _____	_____
<u>Economic Opportunity Goals</u>	
___ Support activities to meet changing economic conditions	
___ Provide energy-efficient transportation	_____
___ Provide developments with transit-supported capabilities	_____
___ Target economic export activities	_____
___ Attract and maintain workforce	_____
___ Promote infill of smaller, passed-over sites	_____
___ Encourage redevelopment of older areas for new purposes	_____
___ Other _____	_____
<u>Ecosystem Protection Goals</u>	
___ Protect ecosystems	
___ Minimize fragmentation	_____
___ Promote native species	_____
___ Protect rare and keystone species	_____
___ Protect sensitive environments	_____
___ Maintain natural processes	_____
___ Maintain natural structural diversity	_____
___ Protect genetic diversity	_____
___ Restore modified ecosystems	_____
___ Other _____	_____

Name
Affiliation
Date

Reviewed by: _____

FIGURE III-5

STUDY AREA DIRECTIONS AND GOALS CHECKLIST

(Check where applicable)

Project Name: _____ Location: _____ Analyst: _____ Date: _____

1. **Generalized Setting**
 Within Metropolitan Statistical Area (Identify MSA) _____
 Outside of MSA _____
 Both Inside and Outside MSA _____ Indicate Distance to Nearest Metropolitan Center _____
2. **Characteristics of Transportation System** (Note: These items are not intended to cover entire transportation need but rather to use information from more detailed assessments to provide a preliminary indication of existing accessibility, service and modal interrelationship characteristics, i.e., factors relevant to subsequent indirect effects analysis).
 - Identify missing links in transportation system _____.
 - Map and describe existing level of service on minor and principal arterials and their access characteristics.
 - Indicate distance to nearest interstate highway if not in study area.
 - Map and describe existing transit routes and demand.
 - Map and describe major concentrations of existing and planned development.
 - Describe modal interrelationships including competing and complementary characteristics.
3.

<u>Population</u>	<u>Trend</u>	<u>Projection</u>
Declining	_____	_____
Static (~ 1%/10 years)	_____	_____
Slow Growth	_____	_____
Rapid Growth (>10%/10 years)	_____	_____
<u>Employment</u>	<u>Trend</u>	<u>Projection</u>
Declining	_____	_____
Static (~ 1%/10 years)	_____	_____
Slow Growth	_____	_____
Rapid Growth (>10%/10 years)	_____	_____
4. **Planning Context**

	Yes	No	If yes, identify by title, agency and date
Zoning	_____	_____	_____
State Master Plan	_____	_____	_____
County/Regional Master Plan	_____	_____	_____
Municipal Master Plan	_____	_____	_____
Growth Management Plan	_____	_____	_____
Water Quality Management Plan	_____	_____	_____
Other Natural Resources Management Plan	_____	_____	_____
5. **For each plan identified in No. 3, summarize key goals, elements and linkages to other plans (specify, in particular, elements related to economic development, land use development, the transportation system, and natural resource protection).** _____

6. **Describe any efforts to elicit local needs and goals from residents and/or agencies (source and result).** _____

7. **Describe known plans for major new or expanded activity centers including public facilities.** _____

 Is the activity center dependent on transportation system improvement? Yes _____ No _____
8. **Is the transportation need linked to economic growth and land development?** Yes _____ No _____
 If yes, is the nature of the linkage to:
 Serve the needs of planned growth _____ or
 Channelize growth _____ or
 Stimulate growth _____ or
9. **Based on information obtained, are there any apparent conflicts between transportation and other needs that could result in controversy? (Describe).**
 Yes _____ Possible _____ No _____

Reviewed by: _____ Name _____ Affiliation _____ Date _____

Step 2B - Public Involvement

Of course, it is important to deal with facts, particularly when facts are readily obtained. However, facts tell only part of the story (or do not exist for all items of interest). Perceptions of directions and goals or opinions about them can be valuable in establishing a “big picture” context.

A number of public involvement techniques are advocated for obtaining the perceptions or opinions. For example, the U.S. DOT document, *Innovations in Public Involvement for Transportation Planning* (1996), is a notebook which outlines various practical techniques of public involvement that can be used in a variety of situations. The reader should consult these and other pertinent documents for details. A comparison of techniques relevant to goals development includes:

- < *Visioning* - This technique typically consists of a series of meetings focused on long-range issues. It looks for common ground among participants in exploring and advocating strategies for the future. With overall goals in view, it avoids piecemeal and reactionary approaches to addressing problems. It accounts for the relationship between issues, and how one problem's solution may generate other problems (e.g., indirect/cumulative effects). To be balanced, visioning requires involvement of all stakeholders, and a cross-section of citizens. Resources required for visioning typically include a staff leader committed to the process, a community participation specialist who is well versed in the applicable subject matter, and staffers who can interpret and integrate participants' opinions from surveys and meetings. If forecasts of information are developed or if alternative scenarios are to be fleshed out, research and preparation time can be extensive.
- < *Citizen Survey* - This technique is used to assess widespread public opinion through a survey administered to a sample group of citizens via a written questionnaire or through interviews in person, by phone, or by electronic media. Surveys can be used to obtain information for determining residents' perceptions of an area's future directions and goals. Surveys can be informal or formal (scientific) with formal surveys being more expensive and requiring a higher level of expertise. Survey respondents should be selected to provide a composite view of the larger population. In this respect, a survey can capture the views of those who are not ordinarily informed or involved in transportation processes (including those who may not have the time to participate in visioning or other public involvement initiatives). One drawback of the survey is that it is not interactive.
- < *Focus Group* - The focus group is another tool to gauge public opinion, and identify citizen concerns, needs, wants, perceptions and expectations. A focus group is a small group with professional leadership. Participants in a focus group are selected in two ways: random selection to assure representation of a cross-section of society or non-random selection to help elicit a particular position or point of view. A focus group can help conform or deny established goals. A focus group is relatively inexpensive compared with the costs and effort of administering a full opinion survey.
- < *Collaborative Task Force* - A group of community leaders and private citizens could be formed as a task force that would meet periodically throughout the process of

indirect/cumulative effects analysis. The task force could provide direction and consultation on the methods, assumptions and analysis results and serve as the first venue for a visioning or focus group exercise.

A collaborative task force has these basic features:

- a sponsoring agency that is committed to the process;
- a task force formed of representative interests;
- emphasis on resolving an issue through task force consensus;
- detailed presentations of material and technical assistance for complete understanding of context and subject matter; and
- serial meetings to understand and deliberate the issues.

A collaborative task force can require relatively significant resources. Among these are an experienced, neutral facilitator; staff technical support; presentation materials understandable to lay individuals; and, usually, specialized consultants. Several meetings are likely, each consuming several hours.

Any public involvement effort should be inclusive and comprehensive. A proactive position toward recruiting participants should be taken and every effort should be made to represent the full range of community interests in visioning, focus groups, or surveys. The goals of low income, minority or other traditionally disadvantaged populations must be considered along with those who may be more active in the community. A list of those who may have valuable input into the process includes those with knowledge of or interest in local land use decisions.

List of Potential Visioning, Focus Group, and Task Force Members

Municipal or County Legislative Members	Community/Neighborhood Group Leaders
Mayors and County Executives	Environmental Organizations
Tribal Leaders/Representatives	Land Conservation Organizations
MPO Representatives	Religious Leaders
Regional Planning Authority	Business Owners and Executives
Representatives	Chamber of Commerce Representatives
Zoning/Planning Board Members	Realtors
Local Transportation/Transit Officials	Bankers
Public Safety Officials	Developers
Public Works Officials	Farmers
Board of Education Officials	Building Managers/Business Park
Economic Development Officers	Operators
Utility Representatives	Other Private Citizens

There is obviously some sensitivity involved in exploring the directions and goals of plans developed by others. For this reason, visioning is often appropriate as a public involvement tool in certain situations for determining or confirming the area's directions and goals for the future at a broad level. Visioning can be used to develop alternative future scenarios for eventual comparison to the proposed project scenario. The citizen survey or focus group techniques can be used to support visioning when more details about directions and goals are required. Task forces can be employed in more complex project circumstances.

Work Product for Step 2

The product of work for Step 2 consists of comprehensive lists (completed Figure III-4 and III-5 checklists, for example) detailing study area goals and trends. The lists can be used to support a technical memorandum which synthesizes the study area's relevant plans, trends, policies and shaping forces. The technical memorandum is suggested in more complex situations.

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Chapter 3

Step 3 - Inventory Notable Features

Overview

An inventory of baseline environmental conditions is another step of the scoping process, and is typically done as a project proposal is being developed, usually prior to the NEPA class of action determination. The typical inventory is fairly routine and the sources of data to undertake the typical inventory are relatively well established. The baseline environmental inventory can be used as a tool to identify notable features or specific valued, vulnerable, or unique elements of the environment. Because indirect/cumulative effects analysis often involves a study area larger than that which may be necessary for analysis of direct impacts, attempts should be made to incorporate consideration of a study area for indirect/cumulative effects early in the planning or project development process. An analysis of indirect/cumulative effects occurring after the initial screening effort should utilize previous work on notable features, expanding the review to match study area boundaries or modifying it to meet the needs of indirect/cumulative effects analysis as necessary. The objective of this step is to identify specific environmental issues within the indirect/cumulative effects analysis study area against which the project may be assessed.

This chapter will:

- < discuss general considerations in developing an inventory of notable features;
- < define the range of notable features relevant for inclusion in the inventory, including those addressed by federal statutes;
- < review data sources and methods useful in developing the inventory; and
- < provide checklists useful in applying this step to practice.

Considerations

Whether from encroachment-alteration or project-induced growth, or in combination with other actions, indirect and cumulative effects from transportation project change the environment. Society has preferences for how much change is acceptable. The acceptability of the degree of change varies depending on the affected setting or population. A number of terms are found in the literature that describe settings or populations commonly afforded special attention with respect to change. The

term *notable features* is used in this handbook as an overarching term that encompasses the various terms found in the literature. This term includes the following aspects of the human environment:

- < *Sensitive species and habitats* - U.S. EPA uses terms such as sensitive species and habitats noting that the term sensitive applies to ecologically valuable species and habitat, and those vulnerable to impact. U.S. EPA added that rarity is often a good indicator of vulnerability. (EPA, 1994) U.S. EPA notes other characteristics as being indicative of vulnerability as:
 - species requiring high survival rates rather than high reproduction rates.
 - species whose intrinsic rates of increase fluctuate greatly.
 - communities with vulnerable keystone predators or mutualists.
- < *Valued environmental components* - Irwin and Rodes (1990) use the term valued environmental component as a "characteristic or attribute of the environment that society seeks to use, protect, or enhance."
- < *Relative uniqueness, recovery time, unusual landscape features* - Forman and Godron (1986) use the terms *relative uniqueness* and *recovery time* as measures of a landscape element's (ecosystem's) value. Relative uniqueness is "a measure of how many comparable examples of this landscape element exist at different levels of scale, from the local area to the nation, even the globe." Recovery time is "a measure of how long it would take to replace the existing landscape element in comparable form if it were disturbed or destroyed." The authors also note the importance of *unusual landscape features*, that is, "types of landscape elements only found once or a few times across an entire landscape." Such features, e.g., a single major river in a landscape, are notable as activity centers "where flows of species, energy, or materials are concentrated."
- < *Vulnerable elements of the population* - The field of social impact assessment also recognizes vulnerable elements of the population (ICOGP, 1993). It has been suggested that vulnerable segments of the population of a neighborhood or community include the elderly, children, the disabled, and members of low-income or minority groups. Such segments may be more at risk from the effects of air pollutant emissions (e.g., the elderly, children), susceptible to changes in pedestrian mobility (the elderly, children, the disabled), or typically under represented in providing input to transportation decisions.

What constitutes a notable feature depends on perspective (there are likely many other perspectives or disciplines of study not discussed here that are captured by the term *notable features*). Therefore, the inventory should cast as wide a net as possible on perspectives. Similarly, the definition of notable features in an area depends on scale. What is notable to a region will often differ from what is notable to a community or city. The various geographic scales should be examined in keeping with the CEQ regulations which state that significance varies with context (40 CFR 1500-1508).

Methods

There are several basic steps in assembling an inventory of notable features and a variety of data sources and basic methods to be utilized. To achieve optimum results in later steps of the indirect/cumulative effects analysis process, every element considered here should be mapped using GIS or other cartographic techniques. Subsequent steps in this analysis framework will benefit from generation of overlay maps including notable environmental features, project design features, and subarea boundaries. Basic procedures in this part of the indirect/cumulative effects assessment framework include the following steps.

Step 3A - Assemble Inventory of Ecosystem Conditions

U.S. EPA's report on ecosystem approaches to highway impact assessment (1994) suggests several ecosystem conditions to consider depending upon the setting (suburban, rural, or wildland). Figure III-6 lists those conditions and provides a framework for documentation by the analyst. Data sources for ecosystem conditions include:

- < Nature Conservancy data, available through state Natural Heritage Programs (NHPs) or Conservation Data Centers (CDCs), contain information on regional biological and ecological features including rare species communities;
- < U.S. Geological Survey(USGS) Biological Resources Division, consolidates information on biological and ecological features from several Department of Interior bureaus;
- < U.S. EPA Environmental Monitoring and Assessment Program (EMAP) has developed detailed methodologies and indicators for assessment of baseline ecological conditions. This program is currently in the implementation phase but information on select resources and regions is currently available;
- < state land management agencies;
- < state fish, wildlife, and conservation agencies;
- < state agricultural and forestry agencies; and
- < tribal natural resource offices.

Step 3B - Assemble Inventory of Socioeconomic Conditions

Identification of features in the human social environment begins with an inventory of basic socioeconomic conditions. Figure III-7 details basic economic, demographic, social, and physical

conditions linked to notable features and provides a framework for their documentation. The conditions outlined were drawn from the community impact assessment literature. (Pivo, 1992)

Data required for this step is similar to that required for Step 2 of the assessment framework (see Chapter 2). Data gathering for the two steps should be integrated whenever possible. Potentially useful sources of socioeconomic information are discussed below.

- < *Published statistics* - Existing measures and future projections of demographic and economic factors in an area can be obtained from the following sources:
 - The U.S. Census provides data on population and household demographics, income, education, housing type, journey to work, and length of residence in an area.
 - The number and type of jobs in a study area for current and historical periods may be obtained through data on Covered Employment (ES-202) maintained by state departments of labor and industry. The number of jobs divided by the number of households in a study area determines the jobs/housing balance, a measure of self-containment.
 - In metropolitan areas, MPOs maintain data current employment and population conditions as well as projections for future time periods which account for pending and anticipated development projects.
- < *Other published material* - Locally published sources may be relevant to the study. These include:
 - Local comprehensive plans (see Chapter 2) often include discussions of socioeconomic conditions such as demographics and income; social conditions such as crime rate and social organizations; and physical features, such as densities, form, mix of land uses, and historic structures.
 - Historical studies of communities conducted by historical societies or local universities may provide information on trends and conditions.
 - Newspaper articles may contain information on local conditions, features, and public opinion.
- < *Interviews* - Because of the age or incompleteness of statistics and local plans, it may be necessary to conduct interviews with local government and planning officials to ascertain or confirm information on social and physical conditions.

- < *Public Involvement* - Citizen surveys or focus groups can be useful in identifying what residents like and dislike about the area, and where they would take visitors to give them a feel for the area (uniqueness).
- < *Field Work* - Field investigations may be necessary to confirm secondary source information or to investigate items not identified through readily available information. Following confirmation, the location and extent of inventoried items should be mapped and/or tabulated.

Step 3C - Assemble Inventory of Notable Features

Notable features gleaned from investigations into ecological and socioeconomic conditions may be documented using the framework given in Figures III-8 and III-9. Figure III-8 outlines the major types of notable features. Figure III-9 was prepared to note that through enactment of laws, society as a whole has in effect placed a value on certain resources or determined that certain resources require special consideration before actions like transportation projects are undertaken. The table lists pertinent federal laws; state and local transportation agencies should expand the list to include pertinent state and local laws.

It is possible that a project study area could contain a number of possible notable features, and differing views of what is notable or why it is notable. For these reasons, it is in a transportation agency's interest to have as many interested parties as necessary involved in determining what are notable features for a particular study area, especially when the study area is large in area or contains many complex features.

- < *Collaborative Task Force* - The collaborative task force public involvement technique is ideally suited to consultation on notable features. Following data collection, the transportation agency should assemble a preliminary list of notable features for potential use as impact measures in the indirect/cumulative effects analysis. The same list could be used for direct and cumulative impact analysis, as well. This list would form the basis of discussion at a collaborative task force meeting(s). The final list of selected assessment notable features should reflect the task force consensus.

Application to Practice

Transportation Systems Planning Context

An inventory of notable features is important in the planning of transportation systems because it can help establish need (e.g., improving systems in lower income areas with poor access) and can help planning agencies minimize potential conflict between the proposed systems and notable features. A notable features inventory at this stage of the transportation development process considers features notable on a regional scale commensurate with the systems plan, typically a metropolitan area or multi-county region. This inventory is typically less detailed than that suitable for project evaluation (e.g.,

watersheds vs. individual streams, communities vs. neighborhoods). Development of overlay maps or a GIS database indicating the location and extent of these major socioeconomic and ecological features will help facilitate identification of potential direct, indirect, and cumulative effects early in the process.

Project Evaluation Context

The methods and data sources discussed above are suitable for compiling an inventory of notable features on a broad regional scale or a very local scale. At the project evaluation stage, generating an inventory of features notable in each community or subregion of the study area is appropriate. The step of determining the study area (see Chapter 1) will provide an indication of the level of effort required and areas that will require particular attention.

Work Product of Step 3

The product from the work conducted during this step consists of documents completed in accordance with Figures III-6 through III-9, with an accompanying map or GIS database illustrating the location and extent of each notable feature, where appropriate.

FIGURE III-6 ECOSYSTEM CONDITIONS INVENTORY

Project Name: _____ Location: _____ Analyst: _____ Date: _____

Setting	Describe/Characterize (Map Locations)
_____ Suburban Landscapes Remnant Communities Greenways Remnant Populations Wetlands and Riparian Zones Drainage Patterns Natural Vegetation Diversity	_____ _____ _____ _____ _____ _____ _____
_____ Rural Watersheds Local Ecosystem Integrity Riparian Corridors Endemics and Migratory Species Riparian and Forest Corridors Hydrology Landscape Pattern Diversity Dispersal Routes	_____ _____ _____ _____ _____ _____ _____ _____
_____ Wildland Regional Ecosystems Remote Habitat Contiguous Habitat Habitat Interior Species Unique Environments Structural Components of Interior Habitat Sub Population Movements	_____ _____ _____ _____ _____ _____ _____ _____

Reviewed by: _____ Name _____ Affiliation _____ Date

FIGURE III-7 SOCIOECONOMIC CONDITIONS INVENTORY

Project Name: _____ Location: _____ Analyst: _____ Date: _____

	<u>Describe/Characterize</u>
Economic	
Residents' occupational mix	_____
Jobs in community (mix)	_____
Jobs/housing balance (self-containment)	_____
Income distribution mix	_____
Journey to work (length and mode)	_____
Job growth rate	_____
Business ownership and services characteristics	_____
Demographic	
Population growth rate	_____
Population age mix	_____
Household types	_____
Retired population percent	_____
Social	
Community cohesion	_____
Crime rates	_____
Clubs, sports and organizations participation	_____
Education levels mix	_____
Sense of control over change	_____
Balance of old timers and newcomers	_____
Physical	
Housing stock mix and values	_____
Open space percent	_____
Town area and form	_____
Separation from other activity centers	_____
Residential density	_____
Mix of land uses	_____
Town edge activity	_____
Historic structures and places	_____
Circulation and traffic characteristics	_____
Neighborhood design characteristics	_____
Infrastructure character	_____
Commercial building scale	_____
Town entrance setting	_____
Scenic character	_____
Trees and vegetation presence	_____
Noise levels and timing	_____
Lighting influence	_____

Name

Affiliation

Date

Reviewed by:

FIGURE III-8 NOTABLE FEATURES CHECKLIST

(Check where applicable)

Project Name: _____ Location: _____ Analyst: _____ Date: _____

	<u>Specify</u>
<u>Ecosystem Features</u>	
<input type="checkbox"/> Regional habitats of concern/critical areas	_____
<input type="checkbox"/> Rare, threatened or endangered species and associated habitat	_____
<input type="checkbox"/> Species requiring high survival rates	_____
<input type="checkbox"/> Species whose intrinsic rates of increase fluctuate greatly	_____
<input type="checkbox"/> Communities with vulnerable keystone predators or materialists	_____
<input type="checkbox"/> Other _____	_____
<u>Socioeconomic Features</u>	
<input type="checkbox"/> Substandard amounts of open space and recreation	_____
<input type="checkbox"/> Non-compliance with state and federal environmental laws	_____
<input type="checkbox"/> High concentration of uncontrolled solid and hazardous waste sites	_____
<input type="checkbox"/> Inadequate affordable housing	_____
<input type="checkbox"/> Inadequate access to amenities	_____
<input type="checkbox"/> Economically distressed areas	_____
<input type="checkbox"/> Lack of institutional land use controls	_____
<input type="checkbox"/> High proportion of population consisting of:	_____
<input type="checkbox"/> Minorities	_____
<input type="checkbox"/> Low-income residents	_____
<input type="checkbox"/> Elderly	_____
<input type="checkbox"/> Young	_____
<input type="checkbox"/> Disabled	_____
<input type="checkbox"/> Low proportion of long-term residents	_____
<input type="checkbox"/> Locations of poor traffic flow	_____
<input type="checkbox"/> Other _____	_____

Name

Affiliation

Date

Reviewed by:

FIGURE III-9
NOTABLE FEATURES ADDRESSED BY FEDERAL AND NORTH CAROLINA STATUTES

(Check where applicable)

Resource Type or Area or Issue	Statute/Order	Sources of Information, Data, Map Locations, etc.
Section 4(f) Resources: <input type="checkbox"/> Public Parks and Recreational Lands <input type="checkbox"/> Wildlife and Waterfowl Refuges <input type="checkbox"/> Historic Sites <input type="checkbox"/> Historic or Archaeological Districts <input type="checkbox"/> Archaeological Sites <input type="checkbox"/> Historic Structures	National Historic Preservation Act of 1966 [16 USC §461-470; 36 CFR Part 800]; Transportation Equity Act for the 21 st Century (TEA-21, 1998) [23 USC; PL 105-178 and as amended 105-206]; DOT Act [23 USC §138, 49 USC §303(c), 23 CFR 771.135]; Act for the Preservation of American Antiquities [16 USC §431-433]; American Indian Religious Freedom Act [42 USC §1996]; Native American Grave Protection and Repatriation Act [25 USC §3001-3013]; Historic Bridges [23 USC §144(0)]; Wilderness Act [16 USC §1131-1136]; Land and Water Conservation Fund Act [16 USC §460-4 to 460-11]; National Trails Systems Act (16 USC §1241-1249)	<ul style="list-style-type: none"> • U.S. Department of the Interior, Fish & Wildlife Service (USFWS); U.S. Department of the Interior, Bureau of Indian Affairs; U.S. Department of the Interior, National Parks Service (NPS); National Archives and Records Administration (NARA); U.S. Department of Agriculture, Forest Service (USFS); Bureau of Land Management (BLM); • North Carolina Department of Cultural Resources, Division of Archives and History; North Carolina Department of Environment and Natural Resources (NCDENR), Division of Parks and Recreation; • Local Parks and Recreation Officials; • Local historic preservation and genealogical organizations
<input type="checkbox"/> Coastal Zone <input type="checkbox"/> Coastal Wetlands <input type="checkbox"/> Navigable Waters	Coastal Zone Management Act of 1972 [16 USC 33 §1451-1465; Clean Water Act [33 USC 1344]; E.O. 11990-Protection of Wetlands; Rivers and Harbor Act of 1899 [33 USC 1344]; North Carolina Coastal Area Management Act 1974 (CAMA) [7 NCGS 113A-100-134.3]; North Carolina Water Quality Certification Rules [15A NCAC 2H .0500]; Coastal Barriers Resources Act [16 USC §3501-3510]; CAMA Rules EIS NCAC 7H.0208]	<ul style="list-style-type: none"> • NCDENR, Division of Coastal Management; NCDENR, Division of Water Quality; • U.S. Army Corps of Engineers (USACE); • U.S. Department of Commerce, Marine Fisheries Service; • NCDENR, Division of Marine Fisheries

FIGURE III-9 (CONTINUED)
NOTABLE FEATURES ADDRESSED BY FEDERAL AND NORTH CAROLINA STATUTES
 (Check where applicable)

___ Waters of the United States ___ Jurisdictional Wetlands ___ Coastal Wetlands (see Coastal Zone) ___ Navigable Waters ___ Wetland Mitigation	Clean Water Act [33 USC 1251-1376]; E.O. 11990-Protection of Wetlands; Rivers and Harbor Act of 1899 [33 USC 401 <i>et seq.</i>]; State Watershed Buffer Rules, [15A NCAC 2B .0233, .0242, .0259. And .0260]; North Carolina Water Quality Certification Rules [15A NCAC 2H .0500]; Wetland Restoration Program rules [15A NCAC 2R.100]	<ul style="list-style-type: none"> • U.S. Army Corps of Engineers (USACE); U.S. Coast Guard; • NCDENR, Division of Water Quality • NCDENR, Division of Coastal Management • U.S. Department of Commerce, Marine Fisheries Service; • NCDENR, Division of Marine Fisheries
___ Stream Buffers	State Watershed Buffer Rules, [15A NCAC 2B .0233, .0242, .0259, and .0260]	<ul style="list-style-type: none"> • NCDENR, Division of Water Quality
___ Sedimentation	Sedimentation Pollution Control Act [NCGS 113 A-50-66]	<ul style="list-style-type: none"> • NCDENR, Division of Water Quality
___ Stormwater	NC Regulations 15A NCAC 2H.1000	<ul style="list-style-type: none"> • NCDENR, Division of Water Quality
___ Sole Source Aquifer	Safe Drinking Water Act [42 USC §300F-300J-6]	<ul style="list-style-type: none"> • NCDENR, Division of Water Quality; NCDENR, Division of Environmental Health
___ Floodplains	E.O. 11988, Floodplain Management (as amended by E.O. 12148); Flood Disaster Protection Act [42 USC §4001-4128]; NC Floodplain [NCGS §143-215.51 - 215.61]	<ul style="list-style-type: none"> • Federal Emergency Management Agency (FEMA); • North Carolina Department of Transportation (NCDOT) • Counties and Municipalities
___ Threatened and Endangered Species ___ Rare/Unique Habitat	Endangered Species Act of 1973 [16 USC §1531 <i>et seq.</i>]; Fish and Wildlife Coordination Act [16 USC 661 <i>et seq.</i>]; Marine Mammal Protection Act of 1972 [16 USC §1361 <i>et seq.</i>]; North Carolina Endangered Species Act [NCGS 113-331 to 113-337]; North Carolina Plant Protection and Conservation Act of 1979 [NCGS 106-202.12 to 106-202.22]	<ul style="list-style-type: none"> • U.S. Fish & Wildlife Service (USFWS); U.S. Department of Commerce, Marine Fisheries Service; NCDENR, Division of Marine Fisheries; • NCDENR, Division of Parks and Recreation, Natural Heritage Program; NCDENR, Wildlife Resources Commission (WRC); North Carolina Department of Agriculture

FIGURE III-9 (CONTINUED)
NOTABLE FEATURES ADDRESSED BY FEDERAL AND NORTH CAROLINA STATUTES
 (Check where applicable)

___ Areas of known contamination ___ Solid Waste	Comprehensive Environmental Response Compensation Liability Act (CERCLA) [42 USC §9601-9675]; Resource Conservation and Recovery Act (RCRA) [42 USC 6901 <i>et seq</i> (40 CFR Parts 240-271)]	<ul style="list-style-type: none"> • U.S. Environmental Protection Agency (USEPA); • NCDENR, Division of Waste Management
___ Wild, Scenic or Recreational Waters	Wild and Scenic Rivers Act [16 USC §1271-1287; Public Law 90-542]; Rivers and Harbor Act of 1899 [33 USC 403]	<ul style="list-style-type: none"> • U.S. Department of the Interior, National Parks Service (NPS); U.S. Army Corps of Engineers (USACE); • NCDENR, Division of Coastal Management
___ Surface Water	Classifications and Water Quality Standards Applicable to Surface Waters and Wetlands of North Carolina [15A NCAC 2B .0200]	<ul style="list-style-type: none"> • NCDENR, Division of Water Quality
___ Ground Water	NC Groundwater Classification and Standards [15A NCAC 2L.0100]	<ul style="list-style-type: none"> • NCDENR, Division of Water Quality
___ Prime or Unique Farmland	Farmland Protection Act [7 USC §4201-4209]	<ul style="list-style-type: none"> • U.S. Department of Agriculture (USDA), Natural Resource Conservation Service (NRCS)
___ Sensitive Receptors	Noise Control Act [23 USC §109(i)]	<ul style="list-style-type: none"> • U.S. Environmental Protection Agency (USEPA); • North Carolina Department of Transportation (NCDOT)
___ Nonattainment or Maintenance Areas ___ Sensitive Receptors	Clean Air Act [42 U.S.C. §7609 {CAA §309} 40 CFR Part 93]; NC Clean Air Rules [15A NCAC 2D .0100-.2000]	<ul style="list-style-type: none"> • U.S. Environmental Protection Agency (USEPA); • Federal Highway Administration (FHWA) Southern Resource Center; • North Carolina Department of Transportation (NCDOT); NCDENR, Division of Air Quality
___ Communities and Residential or Commercial Property	Federal Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 [42 USC §4602 <i>et seq</i>]; North Carolina Relocation Assistance Act [NCGS 133-5-18]; E.O. 12898-Environmental Justice	<ul style="list-style-type: none"> • U.S. Department of Commerce, Census Bureau; • Local governments; • Local citizens groups (Church, School, Social, Unions, Chamber of Commerce, Realtors), Individual citizens

FIGURE III-9 (CONTINUED)
NOTABLE FEATURES ADDRESSED BY FEDERAL AND NORTH CAROLINA STATUTES
(Check where applicable)

<input type="checkbox"/> Environmental Justice	Civil Rights Act [Title VI:42 USC §2000D (60 FR 33896) <i>et seq.</i>]; E.O. 12898-Environmental Justice	<ul style="list-style-type: none">• U.S. Department of Commerce, Census Bureau;• Local governments;• Local citizens groups (Church, School, Social, Unions, Chamber of Commerce, Realtors), Individual citizens
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Chapter 4

Step 4 - Identify Impact-Causing Activities

Overview

Steps 2 and 3 of the indirect/cumulative effects assessment framework have focused on the identification of trends, goals, and notable features. The next steps in the framework involve identification of impacts that may come into conflict with these goals and features. Gaining a thorough understanding of features of the proposed project and other existing and proposed activities and the range of impacts they may cause is the first step toward the identification of indirect/cumulative effects. Project impact-causing activities are relevant to two of the three major types of indirect/cumulative effects (see Volume 1, Section 4 for discussion of the major types of indirect and cumulative effects):

- *Encroachment-Alteration Effects* - Effects that alter the behavior and functioning of the physical environment are related to project design features but are indirect in nature because they can be separated from the project in time or distance. These effects can be considered cumulative in nature when they are additive over time or have an interactive (non-linear) net effect on the environment.
- *Access-Alteration Effects (Project-Induced Growth)* - Changes in traffic patterns and the alteration of accessibility attributable to the design of the project can induce residential and commercial growth in the study area. (Effects related to this induced growth constitute the third type of indirect/cumulative effect and are attributable to induced growth itself, not project design features. The factors leading to induced growth related effects will be identified in subsequent steps in the framework.)

The key source of information regarding the features of the proposed project is the project description. Typically, the transportation project description consists of basic information that describes the facility to result from the proposed action or alternative, e.g., estimated year of completion, type and function of facility, project length, termini, and access points, number of lanes, etc. This is especially true in early project stages before detailed information becomes available from preliminary design studies. It is clear from this study's research findings that a more detailed project description than is typical is needed to make indirect/cumulative effects more apparent earlier in the project planning and development process.

The objective of this step in the framework is go beyond the typical project description to flesh out those impact-causing activities that a project will entail. This is consistent with the overall framework objective of promoting consideration of indirect/cumulative effects earlier in the

transportation project development process. This is an exercise that occurs formally or informally during the environmental impact assessment of a project. Research done in support of this indicates that this exercise is typically done by the analysts who prepare the environmental consequences section of the EIS, i.e., after preparation of the affected environment section of the EIS or later in the process rather than sooner. However, as complete a description as possible of the proposed action and alternatives early on, it is possible to begin the process of identifying cause-effect relationships between activities and the context of the study area as defined by goals and notable features.

In addition to the proposed action, cumulative effects analysis requires that other existing or proposed activities in the study area that could affect the notable features described in Step 3 be identified and evaluated. Activities of public agencies or private parties that may have adverse or beneficial effects will be evaluated with the proposed action to determine the net effect on notable features.

This chapter will:

- discuss considerations involved in gathering data on impact causing activities when project specifications are not fully developed;
- outline the major types of impact-causing activities;
- describe attributes of transportation projects that lead to access alteration effects; and
- provide a framework for documentation of other actions and impact-causing activities.

Considerations

A transportation project may involve a number of impact-causing activities. Few details may be known about these activities at the early stages of project planning or development beyond the basic project design concept and scope. Therefore, this step may require some leaps of faith by those developing the description, as well as an understanding that the information provided is for purposes of conceptualizing, not quantifying, effects. In other words, what is important at this point is identification of the types of activities that the project will entail. This step can be accomplished with a level of detail commensurate with 400-scale mapping (or similar).

An understanding of the NCDOT's past practices in similar situations, e.g., bridging of streams versus placing a stream in a culvert, as well as knowledge of relevant sections of the agency's design manual and standard specifications is needed. Some experience is necessary to make judgements on these items.

The project description should also be viewed as a piece that will evolve, and should be updated as details about the project become known with more certainty. In particular, the linking of impacts

and goals/notable features in Step 5 (see Chapter 5) should prompt development of more details on activities that have potential for significant impact, where such details are lacking.

Detailed information regarding other actions in the study area may not be available and would not be necessary for an evaluation of cumulative effects. Rather, the goal is to identify a general stress level on affected resources associated with other activities so that it is possible to determine whether the resources, ecosystems, and human communities of concern are approaching conditions where additional stresses will have an important cumulative effect. (CEQ, 1997) Once this is determined, the effects of the proposed action may be evaluated in context.

Methods

Figure III-10 provides a matrix suitable for documenting other activities that may cumulatively affect notable resources in the study area. Significant existing and proposed activities can be identified during the data gathering and review of community and agency plans necessary for identification of trends and goals (Step 2) and notable features (Step 3). Where activities contributing to cumulative effects are not well defined, a general stress level can be described. For example, individual farms or manufacturing plants need not be identified, but the presence of, or plans for, substantial agricultural or industrial activity should be noted.

Figure III-11 presents a checklist developed from the literature (Leopold, 1971) that can be used to help flesh out typical impact causing activities of transportation projects. This checklist may also be used to document impact causing activities associated with other projects or actions in the study area. For a given project, pertinent impact-causing actions can be viewed as potential catalysts for indirect/cumulative effects.

Available project and plan information should be consulted to complete the checklist. The question for the analyst is does the tabulation provide sufficient information about the breadth, duration, location, and type of activity such that the general types of impacts to be expected from the project can be inferred. If not assumptions will need to be made based on standard practice, as discussed above.

If there is a substantial difference between an assumption and the detail developed at a later time regarding a particular activity, (e.g., use of fill material rather than structure) then an assessment needs to be made of whether or not the difference causes a substantial change in either the identification of potentially significant indirect/cumulative effects (Step 5), the analysis of the effects (Step 6), or the conclusions regarding the acceptability of the effects (Step 8). This assessment can be done using the sensitivity analysis or risk analysis task described in Step 7.

FIGURE III-10
OTHER ACTIVITIES (EXISTING AND PROPOSED) THAT MAY
CUMULATIVELY AFFECT NOTABLE FEATURES

Description/Responsible Party	Location <i>(Describe or Map)</i>	Status <i>(Existing/Proposed)</i>	Type of Potential Conflict with Notable Feature
<i>Residential</i>			
<i>Industrial/Commercial</i>			
<i>Government/Community Facility</i>			
<i>Utilities</i>			
<i>Transportation</i>			
<i>Other</i>			

Project Name: _____ Location: _____ Analyst: _____ Date: _____

The general types of project impact causing activities include:

- *Modification of Regime* - alteration of habitat, flora, hydrology, and other features;
- *Land Transformation and Construction* - construction method, ancillary elements;
- *Resource Extraction* - excavation and dredging;
- *Processing* - storage of supplies;
- *Land Alteration* - landscaping, erosion control;
- *Resource Renewal Activities* - remediation, reforestation;
- *Changes in Traffic* - traffic patterns on project and adjoining facilities;
- *Waste Emplacement* - landfill, waste discharge;
- *Chemical Treatment* - fertilization, deicing; and
- *Access Alteration* - changes in access, circulation patterns, travel times to major attractors. Transportation projects that produce a significant change in accessibility between major nodes of employment, housing, and commercial development can make an area more attractive to development. Basic information regarding a project's propensity to change accessibility can help analysts gauge whether this effect merits investigation. Changes in accessibility imply changes in travel demand and travel patterns. Modeling of travel demand in transportation systems has been common practice for decades, and is required by federal regulations in urbanized areas. In modeling practice, a project (or change in the system) needs to be of a certain size to produce a measurable change in travel demand or travel patterns. Therefore, it follows that only those projects that could produce a measurable change in travel demand or travel patterns (and, thus, accessibility) need to be examined for indirect and cumulative effects in the transportation system context (regardless of whether the project is in an urbanized area or a rural area).

FIGURE III-11 PROJECT IMPACT-CAUSING ACTIVITIES CHECKLIST

Project Name: _____ Location: _____ Analyst: _____ Date: _____

If Yes,

Describe Generally (Source, Breadth, Duration, Location and Type)

	Yes	No	
<u>Modification of Regime</u>			
Exotic Flora Introduction	___	___	
Modification of Habitat	___	___	
Alteration of Ground Cover	___	___	
Alteration of Groundwater Hydrology	___	___	
Alteration of Drainage	___	___	
River Control and Flow Modification	___	___	
Channelization	___	___	
Noise and Vibration	___	___	
<u>Land Transformation and Construction</u>			
New or Expanded Transportation Facility	___	___	
Service or Support Sites and Buildings	___	___	
New or Expanded Service or Frontage Roads	___	___	
Ancillary Transmission Lines, Pipelines and Corridors	___	___	
Barriers, Including Fencing	___	___	
Channel Dredging and Straightening	___	___	
Channel Revetments	___	___	
Canals	___	___	
Bulkheads or Seawalls	___	___	
Cut and Fill	___	___	
<u>Resource Extraction</u>			
Surface Excavation	___	___	
Subsurface Excavation	___	___	
Dredging	___	___	
<u>Processing</u>			
Product Storage	___	___	
<u>Land Alteration</u>			
Erosion Control and Terracing	___	___	
Mine Sealing and Waste Control	___	___	
Landscaping	___	___	
Wetland or Open Water Fill and Drainage	___	___	
Harbor Dredging	___	___	
<u>Resource Renewal</u>			
Reforestation	___	___	
Groundwater Recharge	___	___	
Waste Recycling	___	___	
Site Remediation	___	___	
<u>Changes in Traffic</u> (including adjoining facilities)			
Railroad	___	___	
Transit (Bus)	___	___	
Transit (Fixed Guideway)	___	___	
Automobile	___	___	
Trucking	___	___	
Aircraft	___	___	
River and Canal Traffic	___	___	
Pleasure Boating	___	___	
Communication	___	___	
Operational or Service Charge	___	___	
<u>Waste Emplacement and Treatment</u>			
Landfill	___	___	
Emplacement of Spoil and Overburden	___	___	
Underground Storage	___	___	
Sanitary Waste Discharge	___	___	
Septic Tanks	___	___	
Stack and Exhaust Emission	___	___	
<u>Chemical Treatment</u>			
Fertilization	___	___	
Chemical Deicing	___	___	
Chemical Soil Stabilization	___	___	
Weed Control	___	___	
Pest Control	___	___	
<u>Access Alteration</u> (see Figures 4-3 and 4-4)			
New or Expanded Access to Activity Center	___	___	
New or Expanded Access to Undeveloped Land	___	___	
Alter Travel Circulation Patterns	___	___	
Alter Travel Times between Major Trip Productions and Attractions	___	___	
Alter Travel Costs between Major Trip Productions and Attractions	___	___	
<u>Others</u>			
_____	___	___	
_____	___	___	
_____	___	___	

Reviewed by:

Name

Affiliation

Date

Application to Practice

Transportation Systems Planning Context

Major existing and proposed activities with the potential to impact notable features can be identified through a review of agency plans (regarding land use, transportation, capital improvement, resource management) and existing land use, environmental, and socioeconomic conditions in the study area.

A thorough accounting of baseline existing and future conditions will provide the context for evaluation of indirect and cumulative effects.

For the proposed plan, the general attributes of each component or mode should be described in as much detail as possible using Figure III-11 as a guide. These descriptions would be based on assumptions derived from standard practice, previous experience or professional judgment. The location of potential impact causing activities should also be described in a general manner.

Project Evaluation Context

Features of the proposed project and other actions that may result in impacts should be described with as much specificity as possible with assumptions substituted for detailed information as necessary. A list should be made of assumptions used to fill in gaps where details about activities are lacking. This list should be consulted and updated as details are developed but no less frequently than the inception of each subsequent step of the indirect/cumulative effects assessment process.

Work Product of Step 4

The product of this step consists of a list of other existing and potential activities in the study area that may affect notable features (completed Figure III-10) and a list (completed Figure III-11 checklist) of the impact-causing actions of the proposed action or other actions, in as much detail as possible.

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Chapter 5

Step 5 - Identify Potential Indirect/Cumulative Impacts for Analysis

Overview

Once the features of the proposed project and the baseline conditions of the study area have been established, effects that require detailed analysis may be identified. The objective of Step 5 is to compare the lists of impact-causing activities developed in Step 4 with the inventory of goals, trends and notable features that make up the baseline conditions identified in Steps 2 and 3. The comparison is designed to explore potential cause-effect relationships; and to establish which effects merit subsequent detailed analysis or, conversely, which effects are not potentially significant and require no further assessment.

This chapter will:

- < Describe the range of indirect/cumulative effects related to encroachment alteration, including ecological and socio-economic effects.
- < Describe three types of induced growth effects: effects from projects planned to serve specific land development; effects from projects likely to stimulate complementary development; and effects from projects likely to influence intra-regional land development.
- < Summarize qualitative and quantitative methods that can be used to identify indirect/cumulative effects.
- < Present considerations and a set of questions in decision tree format for assessing the significance of identified effects.

Considerations

The discussion of general issues is organized by the three basic types of indirect/cumulative effects: encroachment-alteration/single source additive or interactive effects; induced growth effects; and effects related to induced growth/multiple source additive or interactive effects. Potential effects in each of these categories should be considered for their relevance to the project and significance in the study area. A discussion of the methods and criteria available for determining relevance and significance of effects follows.

Encroachment-Alteration/Single-Source Additive or Interactive Effects

Alteration of the behavior and functioning of the affected environment caused by project encroachment can be characterized into two broad categories: ecological effects and socioeconomic effects. These effects can be linked to project impact causing activities identified in the previous step. The two main effect types are discussed below.

Ecological Effects

The ecosystem approach embodied in CEQ's biodiversity document (1993) recognizes the "fundamental interconnections within and among various levels of ecological organization." Ecological organization is a hierarchically arranged continuum as illustrated in Figure III-12. Reduction of diversity at any level will have effects at the other levels. Therefore, an understanding of the interconnections can help reveal the chain of events delayed in time or space from the original transportation project action or disturbance on or within a particular level of ecological organization.

The interconnections in ecosystems are numerous and complex. Many ecological communities are constantly changing. However, there is a certain range of possibilities that help define a given community. In the absence of a major disruption, species composition and relative abundance in a community can be expected to vary within definable boundaries, perhaps cyclically or perhaps randomly. Disruption of such systems, e.g., the introduction of contaminants, creates new boundaries, changing the range of possibilities in ways that are not always predictable.

Transportation corridors have a unique impact on ecosystems associated with their linear form. These corridors may function as specialized habitats, conduits of movement, barriers or filters to movement, or sources of effects on surrounding habitats. Improvements within corridors can have consequences to habitats removed in time and distance from the project. Together with other human actions, the cumulative effects can be significant.

The following indirect and cumulative effects of transportation project actions can have important consequences for ecosystems (see Figure III-13):

- < Habitat fragmentation from physical alteration of the environment;
- < Lethal, sublethal and reproduction effects from pollution;
- < Degradation of habitat from pollution;
- < Disruption of ecosystem functioning from direct mortality impacts; and

- < Disruption of natural processes (e.g., hydrology, species competition, predator-prey relations, etc.) from altered energy flows.

The ability of an ecosystem to respond to a disturbance or perturbation from a transportation project is a function of its *resistance* (the ability of the ecosystem to withstand or resist variation imposed by disturbance or perturbation) and *recovery* (the ability of an ecosystem to respond after being changed). Note that different elements of an ecosystem will have different rates of resistance and recovery which also interact with each other.

FIGURE III-12
COMPONENTS OF BIOLOGICAL DIVERSITY

- **Regional ecosystem diversity:** The pattern of local ecosystems across the landscape, sometimes referred to as “landscape diversity” or “large ecosystem diversity”.
- **Local ecosystem diversity:** The diversity of all living and non-living components within a given area and their interrelationships. Ecosystems are the critical biological/ecological operating units in nature. A related term is “community diversity”, which refers to the variety of unique assemblages of plants and animals (communities). Individual species and plant communities exist as elements of local ecosystems, linked by processes such as succession and predation.
- **Species diversity:** The variety of individual species, including animals, plants, fungi and microorganisms.
- **Genetic diversity:** Variation within species. Genetic diversity enables species to survive in a variety of different environments, and allows them to evolve in response to changing environmental conditions.

The **hierarchical nature** of these components is an important concept. Regional ecosystem patterns form the basic matrix for, and thus have important influences on, local ecosystems. Local ecosystems, in turn, form the matrix for species and genetic diversity, which can in turn affect ecosystem and regional patterns.

Relationships and interactions are critical components as well. Plants, animals, communities and other elements exist in complex webs, which determine their ecological significance.

(CEQ 1993)

FIGURE III-13
SOME POSSIBLE EFFECTS ON ECOSYSTEMS FROM TRANSPORTATION PROJECTS

Direct Effect	Indirect Effect	Some Manifestations	Possible Consequences (from individual effects or combination of effects)
<ul style="list-style-type: none"> Physical Alteration—Habitat Destruction 	<ul style="list-style-type: none"> Habitat Fragmentation 	<ul style="list-style-type: none"> Creation of Smaller Patches Creation of Barriers Creation of More Edges Draining or Ponding 	<ul style="list-style-type: none"> Local extinction of wide-ranging species Loss of interior or area-sensitive species Direct mortality impacts Erosion of genetic diversity and amplification of inbreeding (particularly for isolated sedentary species) Increased probability of local extinction from small population sizes and reduced likelihood of re-establishment (because immigration is inhibited by barriers) Increased abundance of weedy species Generally, reduced biological diversity
<ul style="list-style-type: none"> Introduction of Pollutants—Toxicity and Behavioral Effects 	<ul style="list-style-type: none"> Degradation of Habitat 	<ul style="list-style-type: none"> Changes in Reproductive Behavior and Rates Changes in Food Sources 	<ul style="list-style-type: none"> Changes in Community Structure—relative abundance of various species Changes in Ecosystem Structure and Function
<ul style="list-style-type: none"> Alteration of Natural Processes—e.g., Hydrology, Species Interactions (e.g., competitor and predator—prey), migration 	<ul style="list-style-type: none"> Altered Energy Flows 	<ul style="list-style-type: none"> Changes in Population Sizes from effects on births, deaths, immigration and emigration Changes in Vegetative Structure 	<ul style="list-style-type: none"> Change in Ecosystem Ability to Support Life

Socioeconomic Effects

Encroachment by transportation projects can directly affect the physical nature of a neighborhood in two major ways:

- < alteration of traffic patterns and access; and
- < relocation of homes and business, or relocation or alteration public facilities.

These direct effects can result in indirect/cumulative effects that can be magnified by the cumulative impacts of other actions. These effects include alterations to:

- < neighborhood cohesion;
- < neighborhood stability;
- < travel patterns of commuters and shoppers;
- < recreation patterns at public facilities;
- < pedestrian dependency and mobility;
- < perceived quality of the natural environment;
- < personal safety and privacy; and
- < aesthetic and cultural values.

These variables should be used to explore effects of changes in the physical environment from transportation projects. For example, a highway project can physically alter the local street network and/or increase traffic volumes on local streets, both of which could effect pedestrian mobility and consequently, interactions and neighborhood satisfaction.

The categorization of effects on the environment presented in Figure III-14 can be a useful tool for identifying socioeconomic indirect/cumulative effects. Of particular note is the opportunity-threat category of effects, i.e., those that can occur while a project is planned but before construction. Examples include effects on real estate investment and maintenance of property. Such effects may indicate the long-term indirect/cumulative effects that can be expected once a project is implemented.

It is important to note that the ecological and socio-economic encroachment-alteration effects described above can also arise from induced growth which is itself an indirect effect. Induced growth effects are described below.

FIGURE III-14
CONCEPTUAL APPROACH TO EFFECT IDENTIFICATION

System Affected	Temporal Phase		
	Opportunity-Threats	Development/Event	Adaptation/Post-Development
Physical	Anticipatory construction or lack of maintenance, decay of existing structures and facilities.	Potential massive alteration of the physical environment, construction of new and upgrading of existing facilities.	Creation of development-specific facilities, deterioration of alternative productive facilities, destruction of environment.
Cultural	Initial contact, new ideas, potential for loss of cultural continuity.	Suspension of activities that assure cultural continuity (e.g., subsistence harvest).	Gradual erosion of culture: loss of unique knowledge, skills, and/or perspectives.
Social	Organizational changes; investment of time, money, or energy for support or resistance; differences in interpretation of risk.	Population increase, influx of outsiders: decline in density of acquaintanceship: social change.	Gradual loss of social human capital (e.g., organizational networks and skills, replacements having limited optional application).
Political/Legal	Litigation to force or block proposed development, heightened political claims-making.	Intrusion of development activity into community politics, litigation and conflict over activity impacts.	Zoning and regulatory changes in search of new development, new laws/ruling in response to impacts.
Economic	Decline or increase in property values, speculation, investment.	Traditional boom/bust effects, inflation, entrance of outsiders into local labor market.	Loss of economic flexibility, specialization of business.
Psychological	Anxiety, stress, anger: gains or losses in perceived efficacy.	Stress associated with rapid growth, psycho-social pathology, loss of efficacy.	Acquisition of coping strategies that are potentially maladaptive under future scenarios.

Source: Gramling and Freudenberg, p. 218.

Induced Growth Effects

Transportation improvements often reduce the time-cost of travel, enhancing the attractiveness of surrounding land to developers and consumers. Development on vacant land, or conversion of the built environment to more intensive uses, is often a consequence of highway and transit projects. Growth in population and employment attributable to a direct project effect (change in accessibility) is an indirect effect that, in turn, produces its own effects on the environment.

Important characteristics of induced growth are described below and illustrated in the attached figures:

- < The land-use impacts of highway investment vary depending on existing land-use conditions in the project area (see Figure III-15).
- < Transportation investments can prompt changes in economic, social, and demographic conditions which can alter location decisions and land use (see Figure III-16).
- < A transportation investment and the increased accessibility that it brings is just one factor in the development decision-making process (see Figure III-17). Other factors include:
 - location attractiveness (physical features; suitability for development; land price and development costs; adjacency to markets, customers, and demand generators);
 - consumer preferences (for local features, existing/anticipated development);
 - the existence/availability of other infrastructure (water, sewer, communications);
 - local political and economic conditions (tax rates, incentives, regulatory environment, availability of labor and capital); and
 - the rate and path of urbanization in the region.

Induced growth effects fall into three general categories: effects of projects planned to serve specific land development, effects of projects likely to stimulate complementary development, and effects of projects likely to influence interregional locational decisions. These induced growth types are discussed in detail below.

Projects Planned to Serve Specific Land Development

Transportation projects designed specifically to serve existing or planned large land development projects or groups of projects require a thorough analysis of induced growth and related effects. This is because:

- < land development is not just probable but highly likely;
- < the magnitude and timing of the development are known or generally predictable; and
- < details of development projects are known and can be analyzed for environmental effects.

Since the land development projects are known, analysis of this type of growth is of importance to indirect/cumulative effects analysis. With details about development in hand, analysis will focus on impacts related to the magnitude and timing of development than its probability of occurrence.

Figure III-15 **HIGHWAY INVESTMENT IMPACT ON TYPICAL PROGRESS OF URBANIZATION**

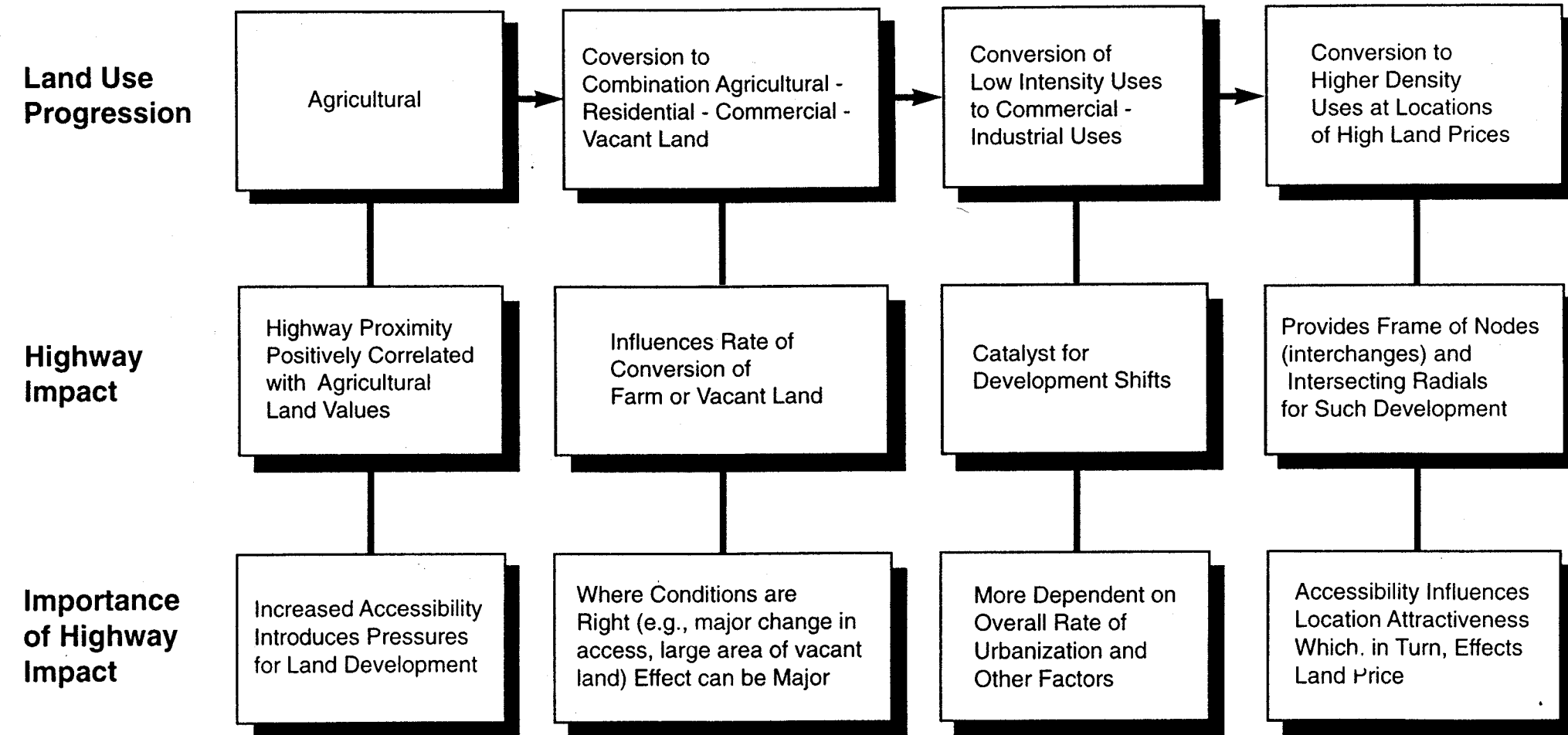


Figure III-16

TRANSPORTATION ACCESS-LAND USE CHANGE LINKAGE

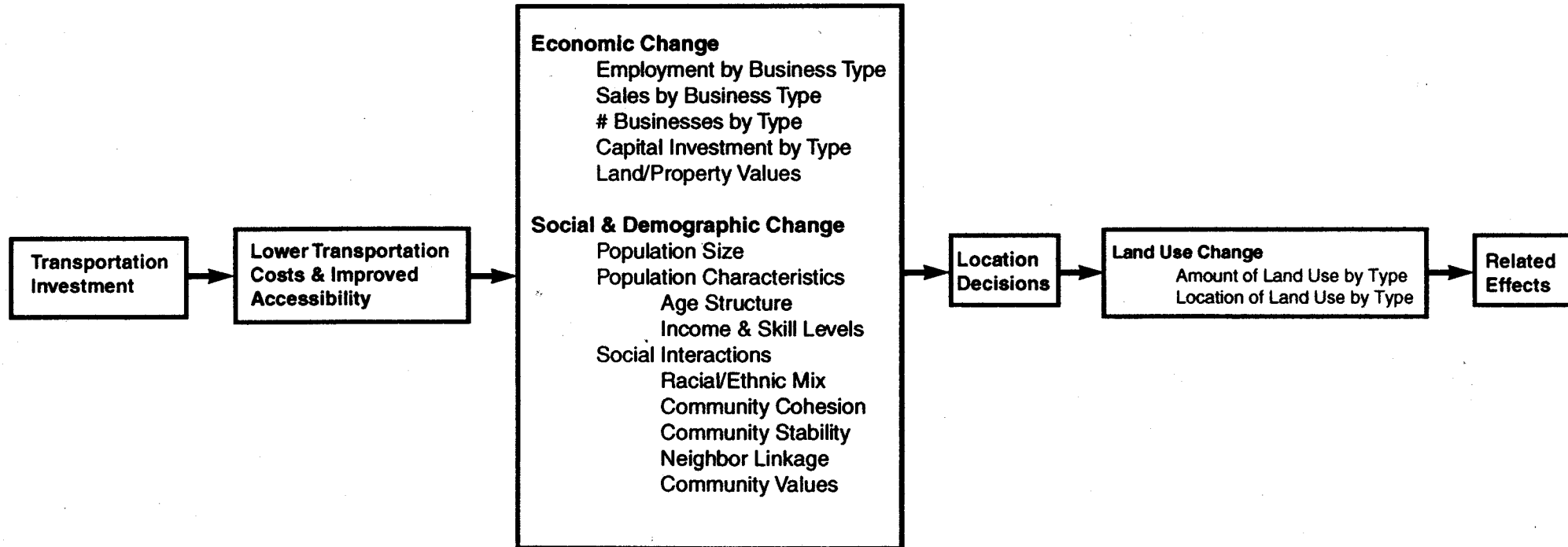
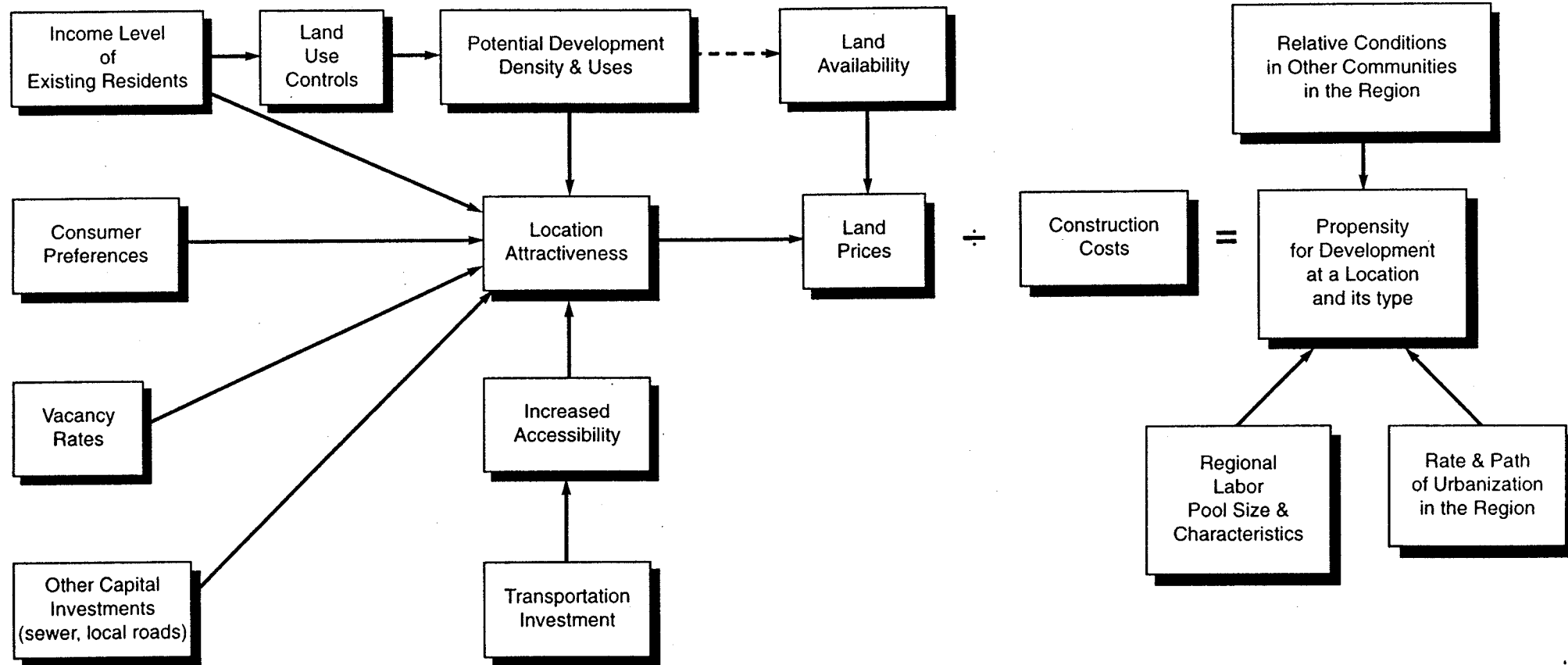


Figure III-17

SIMPLIFIED MODEL OF VARIOUS FACTORS INFLUENCING DEVELOPMENT LOCATION DECISIONS



Projects Likely to Stimulate Complementary Land Development

Complementary land development, such as highway-oriented businesses (e.g., gas stations, rest stops, motels), is more likely near interchanges in rural areas where property values were originally low. Interchanges in suburban or urban areas where property values were higher before project planning and implementation are more likely to support a greater proportion of higher density uses, as well as a greater mix of uses. Factors influencing the likelihood and rate of development near rural interchanges include:

- < distance to major urban area or regional center (proximity corresponds to higher probability of development - see Chapter 6, Figure IV-5 for examples of traffic volumes and corresponding levels of development);
- < traffic volume on the intersecting road (higher volumes correspond to higher probability of development - see Chapter 6, Figure IV-5 for examples of traffic volumes and corresponding levels of development);
- < presence of frontage road (greater potential for intensive development); and
- < availability of water and sewer and other infrastructure (greater potential for development).

If these factors are present, induced growth effects of this type warrant analysis.

Common patterns of development:

- < Interchange quadrants on the right-hand side of motorists approaching the interchange from the main road have higher visibility and are often developed first.
- < Transit projects with stops in suburban or urban areas may produce higher density commercial and residential uses and complementary retail and service development such as coffee shops, dry cleaners, and newsstands.

Projects Likely to Influence Intraregional Location Decisions (Development Shifts)

Apart from the complementary development described above, on a regional basis, the impact of highway and transit projects is generally minimal. The localized effect of such projects on land use can be substantial, however. If the conditions for development are generally favorable in a region, i.e., the region is undergoing urbanization, then highway and transit projects can become one of the major factors that influence where development will occur, and project-induced growth warrants evaluation.

Where transportation projects do influence land development, the general tendency is toward relatively high density commercial or multi-family residential development near facility nodes in urban and suburban areas and single-family residential development in the urban fringe.

Development effects are most often found:

- < up to one mile around a freeway interchange;
- < up to two to five miles along major feeder roadways to the interchange; and
- < up to one-half mile around a transit station.

General circumstances influencing the likelihood of induced development shifts include:

- < *Extent and maturity of existing transportation infrastructure* - The influence of highway projects diminishes with successive improvements because each new improvement brings a successively smaller increase in accessibility.
- < *Land availability and price* - Development cannot take place without the availability of land of a quality and price suitable for development. Property values are de-facto indicators of the potential for land use change because investment decisions revolve around market prices. Land prices are likely to reflect a parcel's suitability for development (favorable topography), the availability of other suitable parcels in the area, the attractiveness of the location and many of the other factors listed below. An abundance of suitable, low priced land maybe indicative of potential development if other factors are present. A scarcity of land or high price does not necessarily indicate a lower probability of development, however. If other factors described here are favorable, high density development may occur where land is scarce or high priced.
- < *State of the regional economy* - Even if changes in accessibility are great, development is not likely to occur if the regional economy will not support new jobs and households, if credit or financing is not readily available, or if firms conclude that the availability of labor, suppliers, or local markets for goods, are not sufficient.
- < *Area vacancy rates* - High local vacancy rates in housing or commercial space of good quality may be absorbed before any shift in development to the project area is seen.
- < *Location attractiveness* - The quality of existing development, local politics, growth history, are all factors considered in addition to transportation availability and cost.
- < *Local political/regulatory conditions* - Low business, property and sales tax rates, the

availability of incentives for development such as tax abatements, and a regulatory environment that is favorable to business are factors favorable to development. The speed, ease, or predictability of the development review process can also impact development costs and is a factor to be considered.

- < *Land use controls* - Development is shaped by zoning ordinances and other land use controls that influence the amount of land available for various uses, the densities permitted, and the costs of development. Pressures for development can prompt communities to alter land use controls, however, and an evaluation should be made which considers the likelihood that changes in land use controls will occur. Such an evaluation can consider the historical record of zoning enforcement and granting of variances, whether the controls are rooted in long range comprehensive plans, and the existing amount of undeveloped land for each use.

If these conditions are favorable for development, a detailed analysis of induced growth and its potential for impact on important area goals or notable features is warranted.

Review of recent indirect/cumulative effects case law (See 4.0 Case Law, Section I, Volume I) suggests that analysis of induced growth effects is required whenever economic development is cited in the statement of purpose and need for the project.

Effects Related to Induced Growth/Multiple Source Additive or Interactive Effects

Project-induced land development and growth can affect the environment in many possible ways. A general tabulation of possible land development effects in terms of economics, the natural environment, aesthetic and cultural values, and public and private services is presented in Figure III-18. A tabulation of possible socioeconomic effects of land development is presented in Figure III-19. Obviously, the degree of certainty, specificity, and need to know about the induced effects will determine the extent that the corresponding related effects should be examined.

One particular effect related to induced growth, the effect of transportation investments on air quality vis-a-vis land use change, has come to the forefront in recent years. From the above discussion, it is clear that transportation investments influence land use under certain circumstances. Empirical data suggests that transportation investments worsen per capita emissions when they support development at the urban fringe, i.e., the location where the lowest density and highest travel consumption are found. From this it is inferred that transportation investments will improve per capita emissions when they create arrangements of land uses that require less vehicular travel.

However, the relationship between travel and land use is complex. For example, income accounts

for a portion of travel variability with land use. In addition, insufficient data is available to determine causality, e.g., whether low density residential development "causes" people to have more vehicle travel or whether people with a proclivity toward extensive auto mobility select low density areas for living. Regardless, the general interrelationships among transportation investment, land use, and air quality merit exploration particularly for those plans or projects that involve the urban fringe (generally high land availability/low land prices in an urbanizing area).

FIGURE III-18
EFFECTS OF LAND DEVELOPMENT AND INDICATORS FOR ESTIMATION

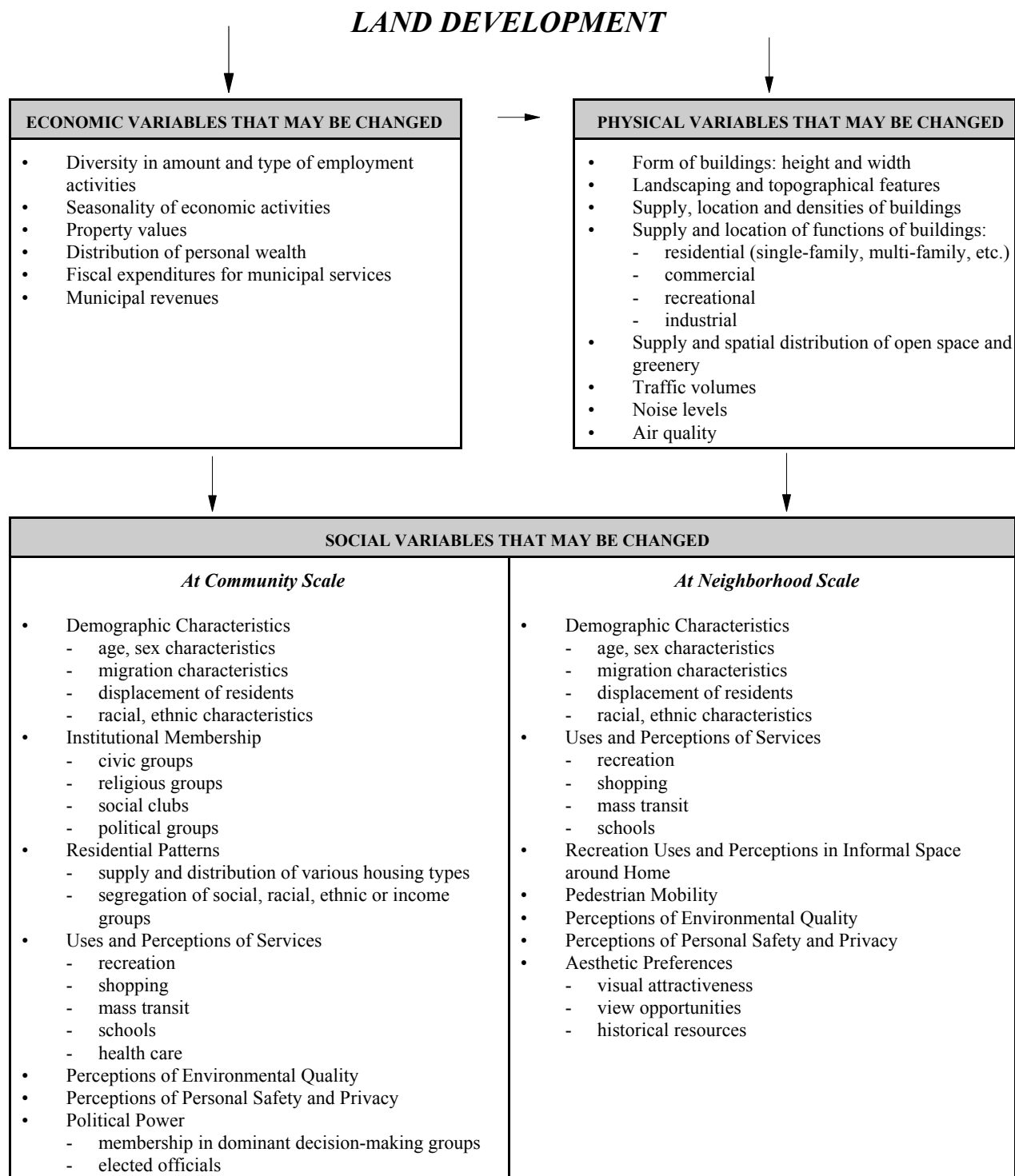
Impacted Sector	Variable	Indicator
Economic	Public Fiscal Balance	1) Net change in government fiscal flow.
	Employment	2) Number of new long-term and short-term jobs provided. 3) Change in numbers and percent employed, unemployed, and underemployed.
	Wealth	4) Change in land values.
Natural Environment	Air Pollution	5) Change in level of air pollutants and change in number of people at risk or bothered by pollution.
	Water Pollution	6) Change in the level of water pollutants, change in tolerably types of use, and number of persons affected, for each body of water.
	Noise Pollution	7) Change in noise and vibration levels, and the number of people bothered by excessive noise and vibration.
	Greenery and Open Space	8) Amount and percent change in greenery and open space.
	Wildlife and Vegetation	9) Number and types of rare or endangered species that will be threatened. 10) Change in the abundance and diversity of wildlife and vegetation in the development and community.
	Scarce Resource Consumption	11) Change in the frequency, duration and magnitude of shortages of critically scarce resources, and the number of persons affected.
	Natural Disasters	12) Change in number of people and value of property endangered by flooding, earthquakes, landslides, mudslides, and other natural disasters.
Aesthetic and Cultural Values	Views	13) Number of people whose views or sightlines are blocked, degraded, or improved.
	Attractiveness	14) Visual attractiveness of the development as rated by citizens and “experts”. 15) Percent of citizens who think the development improves or lessens overall neighborhood attractiveness, pleasantness, and uniqueness.
	Landmarks	16) Rarity and perceived importance of cultural, historic, or scientific landmarks to be lost or made inaccessible.

Public and Private Services	Drinking Water	17) Change in the rate of water shortage incidents. 18) Change in indexes of drinking water quality and safety.
	Hospitable Care	19) Change in number of citizens who are beyond x minutes travel time from a hospital emergency room (using such time as the community considers reasonable). 20) Change in average number of days of waiting time for hospital admittance for elective surgery.
	Crime Control	21) Change in rate of crimes in existing community of new development (or expert rating of change in hazard presented). 22) Change in percent of people feeling a lack of security from crime.
	Fire Protection	23) Change in incidence rates. 24) Change in rating of fire spread and rescue hazards.
	Recreation	25) Change in the number of people within or beyond a reasonable distance (x miles or y minutes) from recreational facilities, by type of facility. 26) Change in usage as a percent of capacity; waiting times; number of people turned away; facility space per resident; and citizen perceptions of crowdedness at recreational facilities. 27) Change in perceived pleasantness of recreational experience.
	Education	28) Change in number of students within x minutes walk or y minutes ride from school, by type of school. 29) Number and percent of students having to switch schools or busing status (from walking to busing or vice versa). 30) Change in crowdedness “breakpoints” (such as needed for added shifts) or indicators (such as student-teacher ratio); and student, teacher, and parent perceptions of crowdedness and pleasantness of schooling.
	Local Transportation	31) Change in vehicular travel times between selected origins and destinations. 32) Change in duration and severity of congestion. 33) Change in likelihood of finding a satisfactory parking space within x distance from the destination or residence. 34) Change in numbers and percent of residents with access to public transit within x feet of their residences; and numbers and percent of employees who can get within x distance of work location by public transit. 35) Change in the rate of traffic accidents (or expert rating of change in hazard presented). 36) Number and percent of citizens perceiving a change in neighborhood traffic hazard; and change in pedestrian usage of streets, sidewalks, and other outdoor space.

Public and Private Services (Continued)	Shopping	37) Change in the number of stores and services, by type, available within x distance of people. 38) Change in the percent of people generally satisfied with local shopping conditions (access, variety, crowdedness).
	Housing Adequacy	39) Change in number and percent of housing units that are substandard, and change in number and percent of people living in such units. 40) Change in number and percent of housing units by type (price or rent range, zoning category, owner-occupied and rental, etc.) relative to demand or to number of families in various income classes in the community.
	People Displaced	41) Number of residents or workers displaced by development — and whether they are satisfied with having to move.
	Population Mix	42) Change in the population distribution by age, income, religion, racial or ethnic group, occupational class, and household type.
	Crowdedness	43) Change in the percent of people who perceive their neighborhood as too crowded.
	Sociability/ Friendliness	44) Change in frequency of visits to friends among people in the existing neighborhood, and frequency of visits between people in the existing neighborhood and the new development. 45) Change in the percent of people perceiving their neighborhood as friendly. 46) Number and percent of people with change in “visual” or “auditory” privacy. 47) Number and percent of people perceiving a loss in privacy.
	Overall Contentment with Neighborhood	48) Change in percent of people who perceive their community as a good place to live.

Source: Schaenman and Miller, November 1974.

FIGURE III-19
POSSIBLE EFFECTS OF LAND DEVELOPMENT
ON SOCIOECONOMIC VARIABLES



Methods

There are a number of techniques discussed below that could support identification of cause-effect linkages between project impact-causing actions and goals and notable features. The techniques can be used individually or in combination. The techniques involve varying degrees of background research.

- < *Matrices* - A project evaluation matrix is commonly a grid diagram in which two distinct lists are arranged along perpendicular axes, e.g., actions and environmental characteristics. The interaction between actions and their environmental characteristics are noted in the matrix. Notation can be made in one of the following forms:
 - *Binary Notation*: Only the presence or absence of an effect is indicated in the matrix through use of a checkmark or other device. This approach is the most straightforward and understandable but does not allow for notation of the magnitude of the impact or recognition of the importance of the resource relative to others in the matrix.
 - *Quantitative Notation*: The magnitude, importance, duration, probability of occurrence, feasibility of mitigation, or other factors relating to the impact could be quantified and noted in the matrix. This method of notation requires a measurable quantity for all impacts. Differences in units used to measure various impacts must be clearly noted. Such differences may make it difficult to compare impacts.
 - *Weighted Notation*: Relative ranking of impacts on a common scale would allow for comparison of impacts, including summation into an overall ranking. A weighting scheme may also be designed to take the relative importance of each impacted resource into account. Weighting schemes may be subjective in nature especially when comparing the value of impacted resources in relation to each other--the methods and criteria employed should be thoroughly reviewed and documented.

While a variety of techniques may be employed to identify indirect/cumulative effects in addition to matrices, the final product of this step in the framework should be completion of the Evaluation Matrix attached as Figure III-22.

- < *Networks* - Also known as system diagrams, networks can be used in classifying, organizing, and displaying problems, processes, and interactions and to produce a causal analysis of the indirect/cumulative effects situation. Obviously, the network is only as good as the underlying understanding or assumptions of often complex processes and interactions. Networks often assume a strict hierarchical relationship among variables that may simplify more complex interrelationships. Network diagrams can include quantitative data in a fashion similar to the methods of notation describe for matrices. Information regarding probabilities may also be noted on network linkages and multiplied as one moves down the effects chain to reach the probability of tertiary effects.

The chains of indirect/cumulative effects illustrated in Figures III-20 and III-21 may be used as the basis for development of either matrices or networks suited to a particular project. Figure III-17 provides an illustration of simple network diagram.

- < *Qualitative Inference* - This technique involves a case study description of an area of concern, e.g., habitat or neighborhood, and an identification based on professional judgement of the possible changes that the proposed project would entail. The case study should focus on the elements or indicators that characterize the area of concern using ecological, economic, demographic, or social profile information from the baseline investigations in Steps 2 and 3. This technique, though practical and simple, has obvious limitations. Foremost among these is slipping into speculation based on limited data or unusual circumstances. Broad participation, including input from local planners, experts, or other stakeholders through surveys, interviews, or task forces can help avoid speculation.
- < *Comparative Case Analysis* - Effects attributable to previously completed projects of a similar nature in similar circumstances can be studied for their applicability to the project under consideration. This comparative technique is described in detail in Chapter 6. Because it is difficult to find cases that are comparable in every respect, care should be taken not to rely exclusively on a comparative case for identification of effects. This technique can be a valuable supplement to other techniques outlined here.
- < *Cartographic Techniques* - Specific techniques, like the McHarg *overlay technique* (1969) which involves the combination of various feature and resource maps, are time-tested. These can be particularly useful for visualizing potential indirect/cumulative effects related to alteration of the physical environment, e.g., habitat fragmentation or community segmentation. Computerized geographic information systems have greatly enhanced the ability to process and display cartographic information. Cartographic techniques are limited in their ability to reveal the structure, function, and dynamics of areas. However, their utility can be expanded by relating inventoried information about these characteristics via a relational database.

Another cartographic technique applicable to identification of indirect/cumulative effects is *resource capability analysis* (Rubenstein, 1987). Similar to the overlay technique, this process involves the preparation of two maps an opportunity map depicting conditions favorable to development (topography, soil types) and a constraint map depicting areas unsuitable for development (wetland, floodplains or other notable features identified in Step 3). Overlaying the two maps produces a land suitability map indicating areas with capacity for potential induced growth. This map could be further modified to indicate areas with the highest potential for complementary development (interchange quadrants) and development shifts (interchanges and feeder roads) under the action alternatives.

Application to Practice

It is likely that some combination of the methods outlined above will be needed in most situations to identify the proposed transportation project's indirect/cumulative effects. This combination would include cartographic techniques for spatial analysis; matrices or networks for visualizing systems' functions, behavior, and interconnections with the project; and either qualitative inference or comparative case study to support the visualization. Further considerations for systems planning or project evaluation are discussed below.

Transportation Systems Planning Context

All of the methods outlined above are applicable to the identification of indirect/cumulative effects in the systems planning stage of the transportation development process. Effects identified in this stage are necessarily broader in nature because project design details are not fully developed. Induced growth and related effects arising from area-wide increases in accessibility will, therefore, tend to be the focus of investigation.

An example of how methods can be combined to identify the full range of indirect/cumulative effects discernable in the planning stage is given below.

- < A simple matrix with binary notation can be drafted using professional judgement or lessons drawn from a review of the literature or similar cases encountered in the planning agency's jurisdiction or other areas. The matrix will show the range of potential indirect/cumulative effects that can arise out of impact causing activities identified during Step 4 (see Chapter 4). More complex effects can be illustrated with network diagrams.
- < The validity of the matrix and the effects identified can be confirmed through consultation with a regional task force or through interviews with local planning agencies or experts. In project with major regional significance it may be appropriate to conduct structured public involvement workshops. The need for local consultation and involvement will be guided by information on trends and goals (Step 2), the location of notable features (Step 3), and whatever information is available on project impact causing activities (Step 4).
- < GIS, resource capability analysis, and overlay techniques can be combined to produce maps noting the location of the following elements:
 - planned transportation improvements,
 - conditions favorable to development,
 - constraints to development (physical and regulatory),
 - notable features, and
 - areas likely to be the focus of changes in accessibility and therefore complementary development or development shifts.
- < The matrix and the mapping exercises should be carefully examined to identify effects meeting the criteria for significance (magnitude and importance).

Project Evaluation Context

The methodology for identification of indirect/cumulative effects during the NEPA/SEPA evaluation of a project would be similar in every respect to the process described for the systems planning phase. Matrices, network diagrams, inference and consultation techniques, and cartographic techniques can be combined for a thorough evaluation. The greater detail on project features and impact causing activities available at this phase allows for greater specification of effects, particularly encroachment/alteration effects. For more complex projects it may be appropriate to quantify or weight effects in a matrix so that magnitude can be assessed and comparison of effects can be conducted. Similarly, more detailed mapping of project features that could produce encroachment or induced growth effects will reveal areas of susceptibility to change or conflict with notable features.

Work Product of Step 5

Regardless of the method or combination of methods employed, tabulation is necessary to organize the information gathered and to make explicit the process used to determine which indirect/cumulative effects should be carried forward to detailed analysis. Figure III-22 presents a decision tree outlining the process for evaluating which effects merit detailed analysis and Figure III-23 provides a table for documenting the evaluation process. The analyst may use the matrix as a framework for listing potential effects under the major categories provided or others revealed during earlier scoping tasks. The particular manifestations foreseeable in the study area should then be documented for each potential effect. In some cases, effects related to induced growth may only be fully identified after the magnitude and location of induced growth has been estimated (Step 6). The matrix can then be revisited to ensure that effects in this category are properly identified for further analysis.

To supplement the tabulation, the analyst should prepare a technical memorandum that describes the indirect/cumulative effects that warrant further analysis, if any, and presents the scope of detailed analysis. The technical memorandum should contain relevant documentation supporting the list of identified indirect/cumulative effects, e.g., checklists, networks, maps, etc., as well as documentation on those indirect/cumulative effects considered but dismissed from further analysis by agreement of the involved parties.

Resources and Supplementary Readings

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Schaenman, Philip S. and Muller, Thomas, *Measuring Impacts of Land Development: an Initial Approach*, the Urban Institute, Report No. URI 86000, November 1974.

FIGURE III-20
EXAMPLES OF INDIRECT EFFECTS

PROJECT ACTION	DIRECT EFFECT	INDIRECT EFFECT	INDIRECT EFFECT	INDIRECT EFFECT	INDIRECT EFFECT
<u>Socioeconomics and Land Use</u>					
Bridge to undeveloped area	-> Improved access	-> Residential development			
Highway extension	-> Improved access	-> Land use development	-> Floodplain encroachment		
Harbor improvements	-> Improved movement of goods	-> Industrial development near waterfront	-> Visual impact on shoreline		
New highway	-> Improved access	-> Land use development	-> Pre-emption of farmlands		
By-pass highway	-> Improved access	-> Development of commercial land uses on by-pass	-> Increased tax revenues from commercial ratables		
Construction of new highway	-> In-migrant Construction work force	-> Income to construction workers spent locally	-> Local businesses hire new employees	-> Population increase because of new employees moving into area	-> Increased demand for community facilities
New highway	-> Improved access to vacant land suitable for industrial development	-> Development of new businesses and industries on these industrial lands	-> Regional economic growth (increased income, employment & earnings)		
New highway bypass around congested downtown area	-> Improved access to vacant suburban land suitable for commercial development	-> New shopping malls and highway-oriented businesses locate on this land	-> Business declines in older downtown area which was by-passed	-> Downtown area deteriorates	
Adopt 'No Action' alternative instead of highway bypass around congested downtown area	-> Additional parking areas and bus routes provided to serve downtown businesses	-> Downtown businesses upgraded	-> More business activity and shopping takes place in downtown	-> Public improvements such as malls, sheltered bus stops, etc	
Adopt 'No Action' alternative instead of highway bypass around congested downtown area	-> Businessmen and planners cannot agree on downtown renewal program	-> Downtown business slows and the area deteriorates	-> The city suffers declines in population, income, employment		

New general aviation airport	-> Aviation-related businesses locate on or near new airport	-> New businesses hire and provide income for local workers	-> Regional economy improves		
Addition of new runway at metropolitan area airport	-> Construction materials purchased in region of airport	-> Local suppliers use increased income for productivity improvements	-> Productivity improvements increase competitiveness of local suppliers	-> Improved competitive position of local suppliers leads to increased employment	-> Regional economic growth results from new employment and income
<u>Water Quality</u>					
Highway extension	-> Improved access	-> Land use development	-> Increased non-point source water pollution	-> Decline in surface water quality	-> Health problems
Highway extension	-> Improved access	-> Land use development	-> Increased non-point source water pollution	-> Contaminants enter water supply aquifer	-> Contamination of groundwater
<u>Wetlands</u>					
New highway	-> Improved access	-> Land use development	-> Many small wetlands eliminated during development	-> Significant aggregate loss of wetlands due to development	
New highway	-> Alteration of surface water drainage patterns	-> Elimination or degradation of downstream wetlands			
<u>Ecology</u>					
New commuter rail line	-> Removal of vegetation and habitat	-> Fragmentation of large habitat area	-> Elimination of species which require this large habitat		
New highway on barrier island	-> Migration of dunes places sand on highway, interrupting traffic	-> Structures built to keep sand off highways	-> Migration pattern of dunes altered	-> Impacts to sensitive barrier island habitat	
New highway in coastal area	-> Culverts built over numerous small streams	-> Interruptions to migration patterns of anadromous fish	-> Juvenile anadromous fish killed in fresh waters	-> Decline in numbers of adult anadromous fish in salt water	-> Decline of commercial fishery for anadromous fish

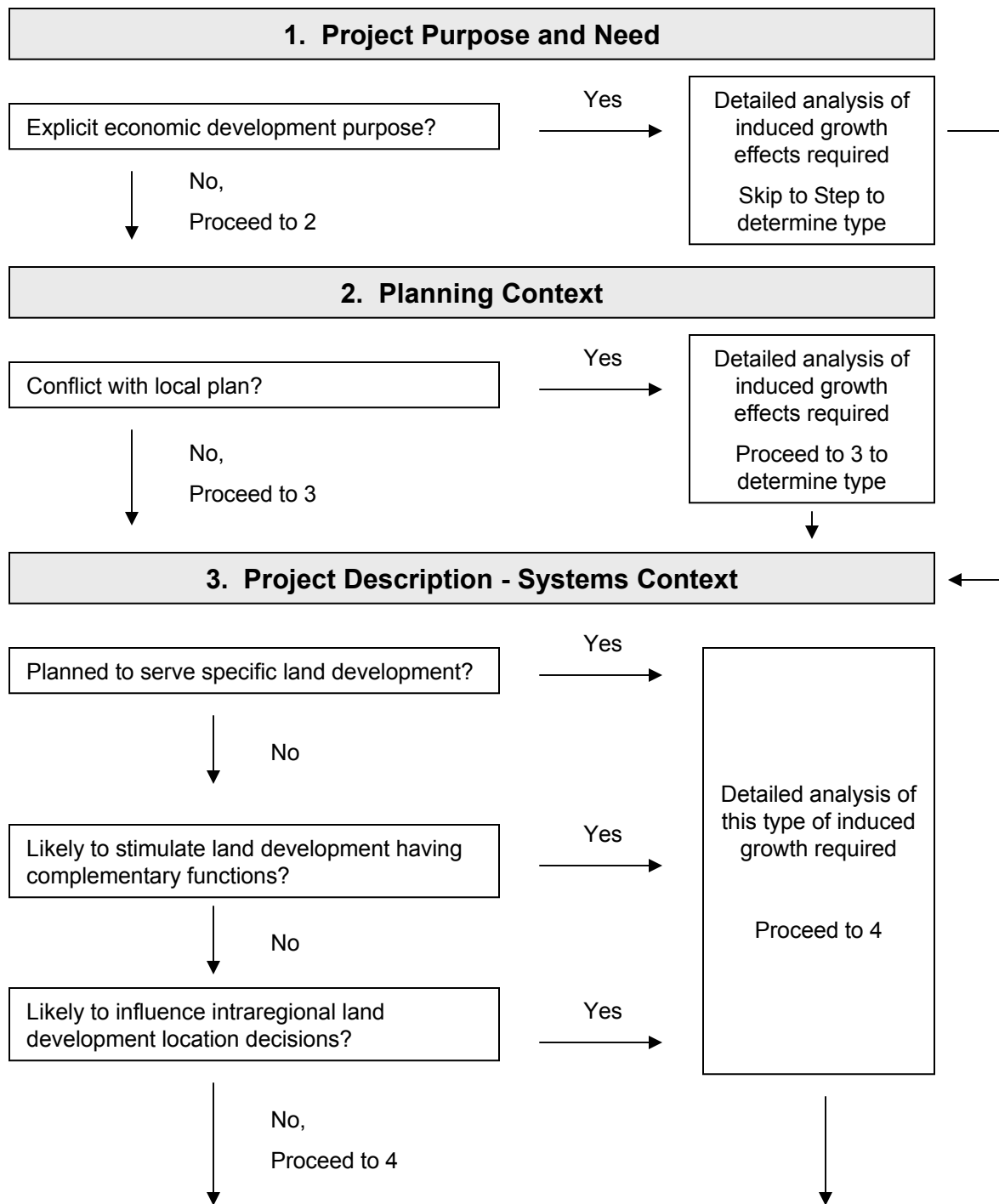
<u>Air Quality</u>					
New highway	-> Improved access	-> Development of new suburban shopping center and associated commercial activities	-> Creation of air quality contamination 'hot spot' exceeding standards	-> Reduction in available increment for future highway projects	
<u>Noise</u>					
New or expanded major international airport	-> New access roads and parking areas required to handle increased passenger load	-> Additional vehicular traffic on these roads produces noise above standards	-> Nearby residential property values are lowered		
<u>Cultural Resources</u>					
New rail mass transit project	-> Improved access for employees to station areas	-> Development of office parks in the vicinity of stations	-> Historic buildings are removed to make way for offices		
New Interstate highway interchange near older city	-> Improved access to nearby rural area	-> Development of land uses in vicinity of interchange	-> Significant alteration of view from historic farm property		
<u>Other</u>					
Highway extension	-> Improved access to undeveloped areas near a city	-> New land use development encounters hazardous waste sites			
New highway	-> Improvement of traffic flow, stabilization of vehicular speeds	-> Reduced fuel usage for vehicles using new highway	-> Reduced utilization of fossil fuels		

FIGURE III-21
EXAMPLES OF CUMULATIVE EFFECTS

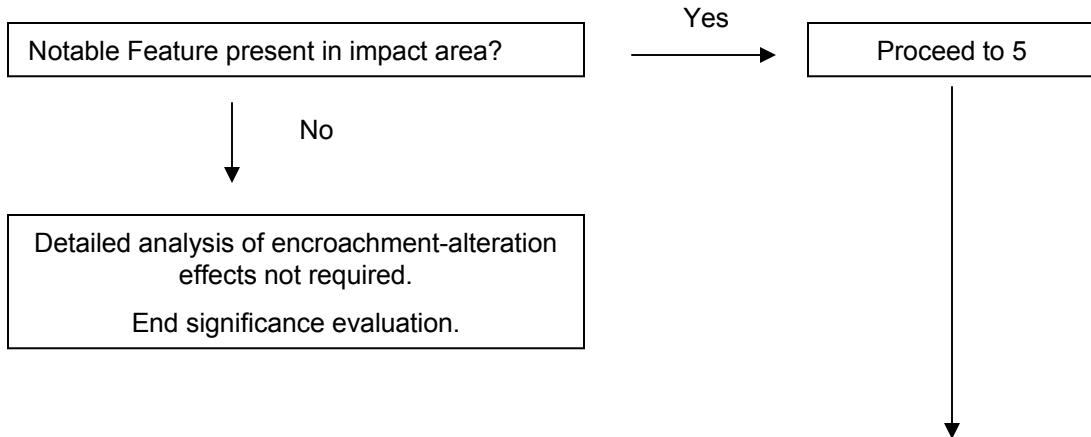
TYPE	MAIN CHARACTERISTICS	EXAMPLE
1. Time Crowding	Frequent and repetitive effects on an environmental system.	Forest harvesting rate exceeds regrowth.
2. Time Lags	Delayed effects.	Exposure to carcinogens.
3. Space Crowding	Highly spatial density of effects on an environmental system.	Pollution discharges into streams from nonpoint sources.
4. Cross-Boundary	Effects occur away from source.	Acidic precipitation.
5. Fragmentation	Change in landscape pattern.	Fragmentation of historic district.
6. Compounding Effects	Effects arising from multiple sources or pathways.	Synergism among pesticides.
7. Triggers and Thresholds	Fundamental changes in system behavior or structure.	Global climate change.

Source: *Considering Cumulative Effects Under the National Environmental Policy Act*, Council on Environmental Quality, 1997.

Figure III-22
Decision Tree for Scoping
Potentially Significant Indirect and Cumulative Effects
Requiring Detailed Analysis



4. Environmental Context



5. Project Description - Design Context

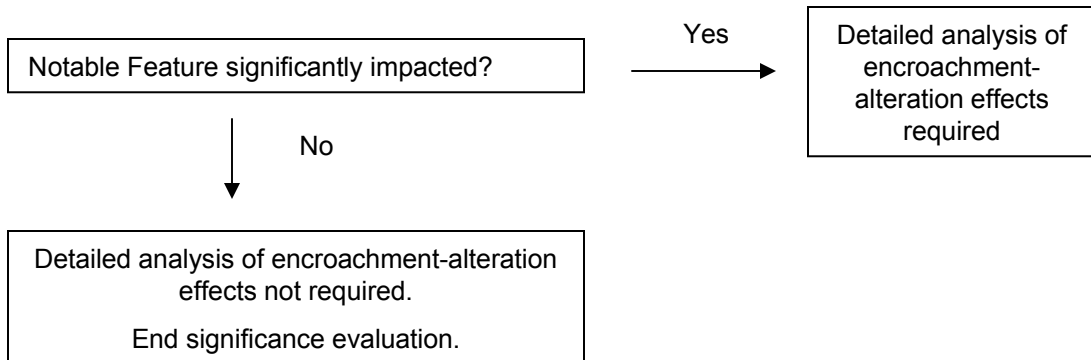


FIGURE III-23
EVALUATION MATRIX
INDIRECT AND CUMULATIVE EFFECTS REQUIRING DETAILED ANALYSIS

Indirect/Cumulative Effect Type		Potential Effect? <i>(Check below.)</i>		Potential Manifestation(s) in Study Area <i>(List below or on separate sheet.)</i>
		No <i>(Assessment Complete)</i>	Yes <i>(Detailed Evaluation Required)</i>	
Encroachment- Alteration Indirect Effects Single Source Additive (Type 1) and Interactive (Type 2) Cumulative Effects	<i>Ecosystem Related:</i> Habitat Fragmentation/Degradation	___	___	
	Ecosystem Disruption	___	___	
	Natural Process Disruption	___	___	
	Air Quality	___	___	
	Water Quality	___	___	
	Noise	___	___	
	Other	___	___	
	<i>Socio-economic/Land Use Related:</i> Community Cohesion/Stability	___	___	
	Alteration of Travel Patterns	___	___	
	Quality-of-Life Effects	___	___	
	Historic Resources	___	___	
	Aesthetic Effects	___	___	
	Other	___	___	
		___	___	
Induced Growth (Access- Alteration Indirect Effects)	Serves Specific Development	___	___	<i>Describe magnitude and location; evaluate related effects</i>
	Stimulates Complementary Development	___	___	<i>Estimate magnitude and location; evaluate related effects</i>
	Influences Location Decisions	___	___	<i>Estimate magnitude and location; evaluate related effects</i>
Indirect Effects Related to Induced Growth Multiple Source Additive (Type 3) and Interactive (Type 4) Cumulative Effects	<i>Ecosystem Related:</i> Habitat Fragmentation/Degradation	___	___	
	Ecosystem Disruption	___	___	
	Natural Process Disruption	___	___	
	Air Quality	___	___	
	Water Quality	___	___	
	Noise	___	___	
	Other	___	___	
	<i>Socio-economic/Land Use Related:</i> Conflict with Goals/Plans	___	___	
	Economic/Fiscal Impacts	___	___	
	Community Cohesion/Stability	___	___	
	Alteration of Travel Patterns	___	___	
	Quality-of-Life Effects	___	___	
	Historic/Cultural Resources	___	___	
	Aesthetic Effects	___	___	
	Other	___	___	
		___	___	

Project Name: _____ Location: _____ Analyst: _____ Date: _____

SECTION IV
ANALYSIS OF INDIRECT/CUMULATIVE EFFECTS

SECTION IV

ANALYSIS OF INDIRECT/CUMULATIVE EFFECTS

Section 101(a) of NEPA, “Declaration of National Environmental Policy,” reads as follows:

The Congress recognizing the profound impact of man's activity on the interrelations of all components of the natural environment, particularly the profound influences of population growth, high density urbanization, industrial expansion, resource exploitation and new and expanding technological advances...declares that it is the continuing policy of the Federal Government, in cooperation with State and local governments, and other concerned public and private organizations,...to foster and promote the general welfare, to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic and other requirements of present and future generations of Americans.

This language has two elements pertinent to indirect/cumulative effects analysis: (1) the recognition of the impact of human activity on the *interrelations* of all components of the natural environment; and (2) implication that the impact should be balanced against other considerations. In the scoping phase, the first of these elements was addressed. Notable features, trends, and goals in the area surrounding the proposed project were identified and the interrelationship between these features and the impact-causing activities of the proposed projects and other activities in the area were explored. The next steps in the framework address the second element of environmental evaluation—the determination of the probability, magnitude, and location of potential indirect and cumulative impacts so that the effects of the proposed project may be evaluated in the context of planning, decision-making, and mitigation considerations.

The analysis of indirect and cumulative effects involves the following steps of the framework:

- < Step 6 - Analyze Indirect/Cumulative Effects; and
- < Step 7 - Evaluate Analysis Results

These steps and the methodologies appropriate for carrying them out are described in detail in Chapters 6 and 7 that follow.

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Chapter 6

Step 6 - Analyze Indirect/Cumulative Effects

Overview

Step 5 of the framework illustrated how to identify potentially significant indirect/cumulative effects. This process of describing the cause/effect relationships between the project and the range of potential impacts to study area goals and notable features provides the foundation for Step 6, the analysis of the potential indirect/cumulative effects. The objective of this step is to assess the significance of the effects identified in the previous step by determining:

- < magnitude;
- < probability of occurrence;
- < timing and duration; and
- < degree to which the effect can be controlled or mitigated.

A variety of quantitative and qualitative tools can be employed in the analysis of potential indirect/cumulative effects. This Chapter will:

- < describe the tools available;
- < outline steps involved in using the tools for indirect/cumulative effects analysis;
- < detail sources for further information regarding each tool; and
- < suggest combinations of tools and steps for basic and detailed analysis applications for systems planning and project evaluation.

Considerations

The first step in the analysis of potentially significant indirect and cumulative effects is to assess the magnitude, location, and probability of project-induced growth. Step 4 of the framework provided criteria for assessing a project's propensity for altering the accessibility of an area and Step 5 detailed the types of project induced growth and the factors contributing to it. If after working through these steps the analyst determines that project induced growth is unlikely then a detailed analysis is unnecessary and the evaluation may focus on encroachment-alteration effects.

Once the level of induced growth has been assessed, impacts on the natural environment arising from the induced development can be evaluated and compared to the impacts of other activities in the study area. Encroachment-alteration effects arising from the project itself should be assessed

a f t e r

induced growth impacts are explored so that these alteration effects can be fully understood in the context of future land uses.

Analyzing induced growth is an exercise in creating and comparing forecasts of future conditions. At least two forecasts are necessary:

- < a Base or No-Action Forecast which describes future conditions in the absence of the project or plan; and
- < an Action Forecast describing conditions in a future point in time following implementation of the project alternative or plan.

These forecasts can be designed to fully consider cumulative effects by including significant past and anticipated actions undertaken by other parties in both the base and project scenarios.

The key in forecasting is an underlying system of logic that can produce reproducible and relatively consistent results regardless of the forecaster. It should be noted that forecasting is not the exact determination and prediction of the future, but the logical extrapolation of likely effects that will occur from known associations among different critical parts of the system.

As with other steps in the framework, induced development forecasting techniques may be either qualitative or quantitative in nature:

- < Qualitative methods can serve to evaluate the context or overall situation wherever little historical data exist or wherever existing data are questionable or inconsistent.
- < Quantitative methods consist of modeling or the search for causal factors, and extrapolation or emphasis on time series.

Whenever possible, forecasts developed for other purposes by regional planning and transportation agencies should be utilized. Use of established forecasts as control totals or baselines will not only reduce the level of effort required in the assessment but will promote acceptance of the findings.

A variety of qualitative and quantitative methods are described below. Examples of how these techniques can be combined and applied to potential planning and project scenarios are addressed at the end of this chapter.

Methods of Analysis

Forecast tools with applicability to indirect and cumulative effects analysis introduced in Step 5 are described below in greater detail.

Qualitative Forecast Tools

Literature Review/Comparative Case Analysis

There is a small but growing body of literature concerning the induced development effects of transportation projects, and other indirect/cumulative effects such as economic benefits to industry arising from increased access and the economic loss to main street business in bypass projects. This literature could be useful in developing sketch scenarios for smaller projects. The literature could also point to instance of comparable cases that merit further study.

A comparative study involves comparing a like area where a similar project has been completed to the area of concern where a project is proposed. There are several important considerations when employing this method:

- < The two projects and areas must be similar in size; project type, location, and design. Demographic conditions, growth rates and other pertinent characteristics must be comparable.
- < Data sources for the two areas and projects should also be similar.
- < Study of the like area essentially consists of beginning with a *retrospective analysis* (or case history) in which adequate information regarding conditions in the area prior to the project would need to be obtained. Although some of this baseline information can be found in available sources such as an EIS, this information may not match the data requirements. In other words, the retrospective analysis estimates conditions which no longer exist, a task that may not be easier than predicting conditions which do not yet exist.
- < Retrospective analyses involve separating project-related impacts from those caused by other factors.
- < A number of effects that may eventually occur because of the transportation project may not have yet occurred, e.g., because of an economic downturn.

Comparative case analysis entails a double effort for data collection and assumes that the proposed project has an accessible twin. Even if similar circumstances can be found, the results may differ because of various random and non-random effects. Objectives and policies, for example, tend to change over time. While it would be preferable to compare the proposed project with several

analogous cases, this would entail more resources. It is obvious that caution must be used in implementing comparative case analysis. However, comparative case does have potential for improved identification of indirect/cumulative effects that are otherwise difficult to identify.

Scenario Writing

Scenarios are an outline in narrative form of some conceivable future environment given certain assumptions about the present and a sequence of events in the intervening period. Multiple scenarios can be drafted to include a variety of changing conditions, a spectrum of potential developments, and a series of hypothetical socio-political, ecological, and economic consequences of proposed actions.

Rather than predictive, scenario writing is a technique which attempts to establish some logical sequence of events to show how, under present conditions and assumptions, a future environment might evolve. Scenarios can also serve to set the upper and lower bounds of potential outcomes.

A particular difficulty in scenario writing is consideration of the various uncertainties in forecasting arising from long-range, future-oriented planning. Included are broader uncertainties about the external planning environment; future intentions of other decision makers; appropriate value judgements; and institutional and social changes. Another difficulty is in uncovering a variety of variables that may not be apparent in the present but which may be of significance in future environments.

There are obvious questions regarding the extent of completeness, validity, or overall accuracy or reliability of scenarios. Effective scenario writing requires continuous questioning of the values, insights, assumptions, and level of information of the scenario writer(s). The level of confidence in scenario writing, therefore, depends on both the plausibility and credibility of the argument, and on the competence and qualifications of the scenario writer(s).

Delphi Technique/Expert Panel Survey/Public Involvement

Thorough surveys of local experts, stakeholders, and professionals can be invaluable in developing assumptions and assessing future conditions. Survey techniques can include informal conversations; formal inquiry following an instrument administered by mail, phone, or interview; or discussions or meetings of a collaborative task force or panel (a sample survey instrument is provided in Appendix A). The most structured consultation method is the Delphi technique. Delphi is a survey research technique directed toward the systematic solicitation and organization of expert intuitive thinking from a group of knowledgeable people (Linstone, 1975). It provides a means for arriving at an informed, objective judgement based upon a variety of sometimes conflicting opinions. Rather than achieving consensus by open discussion, Delphi uses a carefully designed program of sequential individual interrogations interspersed with information and opinion feedback derived from consensus which are computed from earlier parts of the technique.

Figure IV-1 shows the logical sequence of a typical Delphi study and its series of questionnaire rounds. The issues must be structured carefully to bring out the most important questions. This technique provides sensitivity for potential futures and opinions for delineating probable future actions. It can be used to obtain expert opinion on cause and effect relationships and related probabilities when adequate models are not available. Skilled facilitation is required to elicit the experts' opinions. Selection of experts and methods to avoid means of influencing opinion are other important elements of Delphi.

While this technique is less well-defined and requires more expert direction than other detailed qualitative techniques, it can develop ideas and identify causal relationships that might not surface in more structured methods. There are several examples of the technique's application to practice. Recently the Texas Department of Transportation has used the Delphi method to allocate population and employment control totals to Traffic Analysis Zones, in order to evaluate the potential development effects of transportation improvements (Gamble, 1993).

Expert panels or detailed interviews with local real estate, government, and industry leaders may be a workable substitute for the Delphi method when panelists would be unable to participate in an iterative process. Less formal methods, lack the feedback and review features of Delphi but may be used to construct or confirm assumptions employed in other qualitative or quantitative techniques. Project task forces made up of a representative mix of community stakeholders can also help define and refine forecasts techniques and results especially when coupled with public outreach meetings or charettes designed to gauge the range of community expectations regarding project induced growth. Task force and outreach techniques can also serve to build consensus that would promote broad acceptance of findings.

FIGURE IV-1**DELPHI STUDY PROCESS**

Activity	Round 1	Round 2	Round 3
Type of data and information	- Broad trends, events developments	- Agreed developments from Round 1 - Newly suggested items	- Narrowing of items from previous rounds - Detailed analysis of selected trends, events and developments
Inquiry	- When might these take place?	- When might these occur? - Under what conditions? - Justification of extreme views	- Reasons for consensus or non-consensus - Reasons for time estimates - Likelihood and severity of consequences
Analysis	- Collation of statements - Configurations of first agreements - Analysis of commentary	- Summary of selections - Estimation of median - Any additional considerations	- Tabulation of major consequences - Range of agreement - List of selected threatening and desirable items
Suggestions	- What other developments can be suggested? - What is the level of the participant's expertise?	- What major technological and societal consequences may result?	- What can be done to alleviate or mitigate effects? - Reestimates for time horizon or other comments

Quantitative Forecast Tools**Trend Extrapolation**

Trend extrapolation is a commonly used method of projection, based on the analysis of time series data. The technique requires holding the assumption that the factors which contributed to the trend in the past are more likely to remain constant than to change in the time period of future consideration. Future baseline estimates of population, employment, housing starts, and other conditions can be predicted using this method. There are a number of trend extrapolation techniques including:

- < Simple (straight line) extrapolation - finding a line which best fits a plot of time series data and using the linear equation for that line to project data points in future periods.
- < Curve fitting (polynomial, exponential) - finding a curve which best fits a plot of time series data and using the equation for that exponential relationship to project data points in future periods.
- < Asymptotic (upper limit) curves - finding a curve which best fits a plot of time series data with an upper limit on data values; the limit function equation allows for projection of the curve into the future as it approaches an upper limit.

Choice of an extrapolation technique requires judgement based on the data and the situation. For example, exponential curve fitting is best applied to areas growing at a rapid rate. Envelope or asymptotic curves should be employed when known limits on scarce resources such as available land, or sewer and water infrastructure, would inhibit future growth. See Figure IV-2 for examples..

Once the data has been gathered, trend extrapolation projections can be prepared with little effort using standard automated functions of spreadsheets (e.g., Excel, QuatroPro), statistical packages (e.g. SPSS, SAS), or other data processing software.

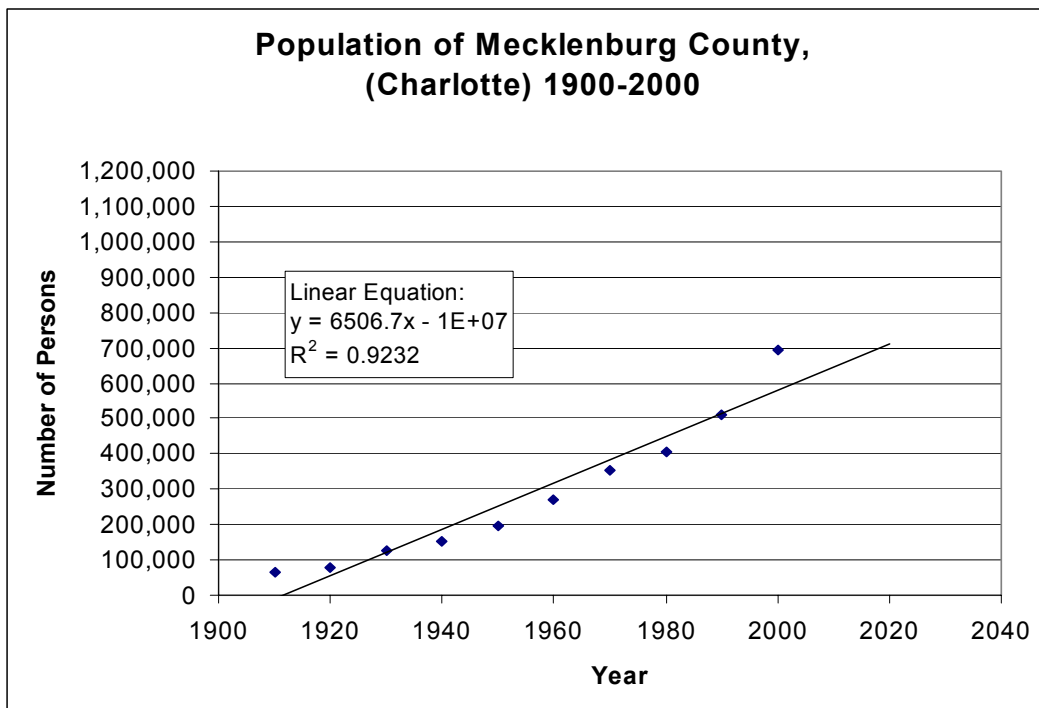
Trend extrapolation techniques are limited in their application to indirect/cumulative effects analysis, because the techniques are only useful in creating base case or no-action forecasts—extrapolation is not helpful in evaluating project alternatives that will by definition change conditions on which historical trends are based. Also, this type of forecasting technique is unnecessary when accepted forecasts have been developed already by local or regional agencies for the study area.

Trend extrapolation techniques have been criticized for being too simplistic. Other drawbacks include:

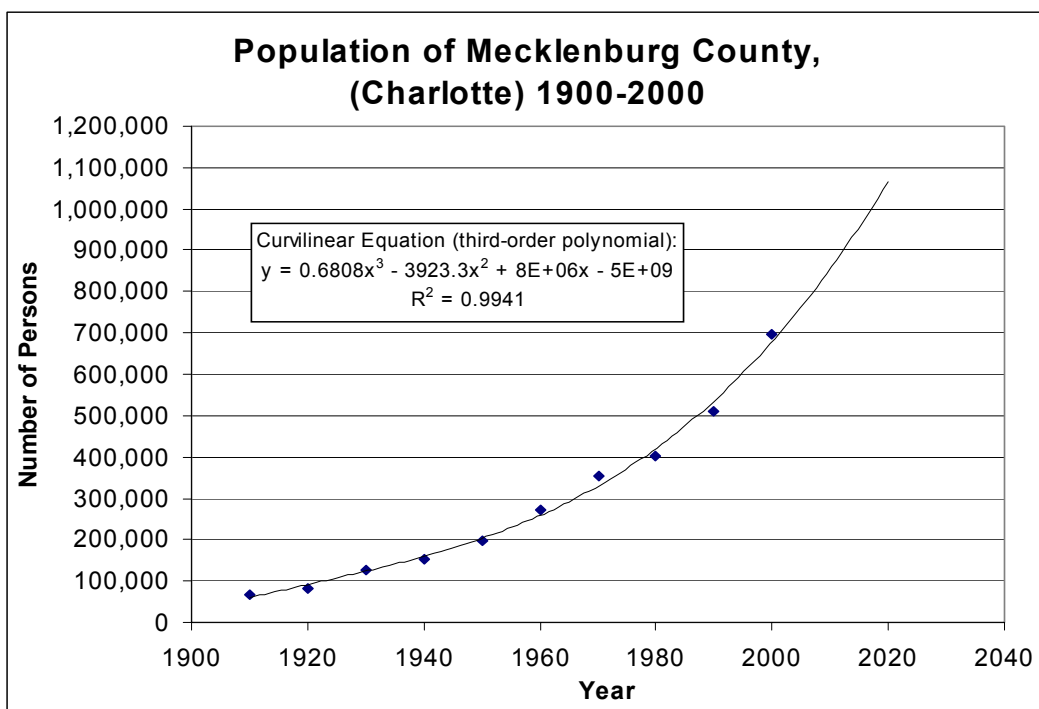
- < Projections taken out too far into the future (more than 5 years) or based on too few historical data points may be seriously flawed.
- < The assumption that conditions supporting past trends are unlikely to change is often unrealistic in an age when technology and public opinion can undergo rapid shifts.

Despite these drawbacks, trend extrapolation can serve indirect/cumulative effects analysis best when, after the trend has been projected, there is detailed exploration of factors supporting continuation of the trend and factors or developments that will alter, limit, or violate the projected trend.

Figure IV-2
Examples of Trend Extrapolation

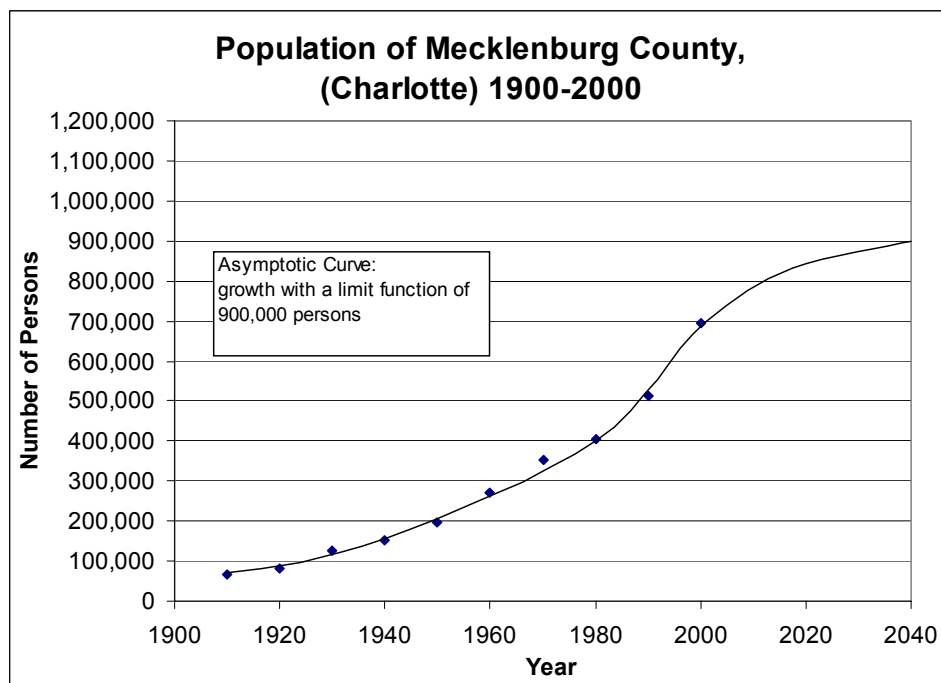


Linear Equation: The linear equation is not the best fitting curve in circumstances where growth becomes exponential.



Curvilinear Equation: A polynomial equation provides the curve with the best fit to the data but projection of the high rate of growth in the past to the future may not be realistic.

Figure IV-2 (cont'd)
Examples of Trend Extrapolation



Asymptotic Curve: Using a limit function to constrain growth to an upper limit may be more consistent with reality but the accuracy of the projection will be entirely dependent on the accuracy of the limit that has been set. The constraint, therefore should be based on a factor that would reasonably be expected to curtail growth, such as the carrying capacity of the land, or limits of the water supply.

Build-Out/Carrying-Capacity Analysis

In a quantitative forecast exercise for indirect/cumulative effects, it is necessary to relate projections of population and employment with consumption of land. Unless this step is integrated into the formal land use model, the analyst must determine standards for land consumption by land use. (Population can be related to land use by determining the number of units per acre and the average household size; similarly, employment can be related to land use by utilizing standards of employees per square foot or per acre for various types of commercial development; see Figure IV-3 for example standards). The goal is to compare how land consumption will differ with and without the proposed transportation improvement.

In areas with established land use controls, the analyst can:

- < develop a no-build scenario by analyzing current regulation and anticipated plans, keeping in mind historical trends in the granting of variances or passage of changes to the zoning ordinance;
- < determine the carrying capacity for each zone given development regulations and environmental constraints and determine when build-out is likely to be achieved;
- < determine if the timing of development is likely to be influenced by the build-alternatives using other quantitative or qualitative techniques described here; or
- < determine if the build alternatives are likely conflict with land use regulations or create development pressures that may result in revision of land use regulations assumed in the no-action scenario.

In areas where land use is not widely controlled or where population projections have not been related to land consumption, it may be necessary to develop a no-action future scenario from scratch utilizing assumptions about location choices and land consumption with and without the transportation improvement. These scenarios can be developed using any of the other quantitative or qualitative techniques described below.

FIGURE IV-3
Typical Values for Land Consumption by Land Use Type

Residential Land Uses

Where available, densities permitted in applicable zoning or development regulations should be used. The table below illustrates typical values.

Housing Type	Units (Households) Per Acre
Rural Single Family Dwelling (SFD)	0.25
Low Density SFD	1.00
Conventional SFD	3.00
Small Lot SFD	5.00
Townhouse	10.00
Garden Apartment	15.00
Mid-Rise Apartment Building	15.00
High-Rise Apartment Building	60.00
Mixed-Use Building	12.00

Non Residential Land Uses

Where available, Floor Area Ratio (FAR) permitted in development regulations should be used in place of typical numbers used below.

Structure Type	Square Feet per Employee	Average Building Size	FAR	Average Lot Size	Average Number of Employees/Acre
Office	333	25,000	0.40	1.43	52.32
Retail	400	10,000	0.20	1.15	21.78
Warehousing/Distribution	667	10,000	0.25	0.92	16.33

Transportation

Streets can be assumed to account for 17 percent of gross land area for all land use types.

Source: Social Cost of Alternative Land Development Scenarios (SCALDS) model, FHWA, 1998.

Regression Analysis/Econometric Forecasting Techniques

Trend extrapolation techniques are used to determine how one dependent variable (such as population, household size, or number of building permits issued) has varied with a single independent variable (time) in the past, so that a prediction may be made about the future. Regression and econometric techniques allow a forecaster to explore the relationship between a dependent variable and several independent variables, either in time-series or cross-section to predict future events. Although many forms of regression analysis may be employed in forecasting, as an example, we will discuss Ordinary Least Squares regression.

The first step in regression analysis is to establish a hypothesis regarding the relationship of an dependent variable such as population to the various independent variables for which data is available at the proper level of aggregation. This hypothesis takes the form of a linear equation. For example, to forecast population growth one could hypothesize that population in a zone is a function of accessibility to employment centers in other zones, land zoned for residential use, housing costs, availability of water and sewer service, and crime rates. The linear equation matching this theoretical model would be:

$$P_j = \$_0 + \$_1(A_j) + \$_2(L_j) + \$_3(H_j) + \$_4(W_j) + \$_5(C_j) + g$$

Where:

P_j = Population in zone j

A_j = Average travel time to major employment centers

L_j = Acres zone for residential use

H_j = Average unit purchase cost for housing

W_j = Presence of water/sewer service

C_j = Crime rate per thousand persons

$\$_0$ = Constant (intercept)

$\$_x$ = Coefficient (slope)

g = Error term

Undertaking a regression analysis and evaluating the statistics produced for an equation like the one above allows the analyst to:

- < determine how well the independent variables explain the variation in the dependent variable (R^2 statistic explains the proportion of variability explained by the model);
- < obtain an indication of relative importance of each variable in the model (t-statistics indicate the strength of the contribution and can be used to determine whether the contribution is significant—insignificant variables should be dropped from the model); and
- < predict the independent variable for any given value of the dependent variables (through application of the coefficients in the equation).

Good data and a well-formed model could be used to predict changes in population or employment

in an area based on changes in an accessibility arising from an project alternative. This would be achieved by varying the accessibility component of the equation while holding other variables constant. Regression analysis could also be used to determine the relative weights of variables determining location attractiveness to be used in a gravity model equation (see below).

Simple Gravity Model

Gravity models follow from the observation that the attractiveness of a location as destination for travel is a function of its “mass” (measured in square footage, for example), and the distance to other similar regional destinations. As in the formula for gravitational attraction used in physics, distance, the denominator, is squared or raised to the power of another exponent to represent its greater importance when compared to mass.

This formulation of mass over distance can also be adapted to predict the location of future concentrations of households or employers as regional accessibility changes. This method allocates predetermined growth in employment and population for a study area to subareas based on mass (the presence of attractors such as population, employment, vacant land, and other factors) and friction (distance between attractors in travel time). Control totals used for allocation can be developed using other forecasting techniques or preferably the totals can be based accepted forecasts developed by state or regional planning agencies.

The process described below is a very simplified version of some of the more sophisticated integrated land use and transportation models. In this formulation the allocation of employment is conducted first and then population is allocated based on employment location. The results derived can be expected to be less accurate than output from formal, calibrated models, but can be used to indicate trends and supplement qualitative analysis based on interviews with local experts. Steps involved in one version of the gravity model are described below.¹

Step 1: Allocate Employment Control Totals to Zones

Step 1A: Determine index of accessibility for each zone

The accessibility index (A_j) for a zone j is calculated as:

$$A_j = \sum_i P_i / D_{ij}^8 \quad i \times j$$

Where:

P_i = Population in each other zone i

¹Adapted from Donald Krueckeberg and Arthur Silvers, *Urban Planning Analysis: Methods and Models*, New York: John Wiley & Sons, 1974.

D_{ij} = Time distance from zone j to each other zone i (from travel model)
 δ = exponent related to friction factor (2, or derived from observation)

Step 1B: Determine employment growth in each zone

Employment growth in each zone (G_j) is calculated as:

$$G_j = G_t (L_j A_j / \sum_i L_i A_i)$$

Where:

G_t = Growth in employment in entire study area (determined exogenously)

L_j = Land (space) available in zone j

L_i = Land (space) available in each zone i

Step 1C: Add employment growth to employment totals and subtract some measure of available land utilized (either estimated or observed) by this growth from L_j .

Step 2: Allocate Population Control Totals to Zones

Step 2A: Determine index of accessibility for each zone

The accessibility index (A_j) for a zone j is calculated as:

$$A_j = \sum_i E_i / D_{ij}^\delta \quad i \times j$$

Where:

E_i = Employment in each other zone i (new totals from Step 1)

Step 2B: Determine population growth in each zone

Population growth is calculated by using the same formula described in Step 1B, substituting estimated growth in population for the study area (G_t), and the new measure of accessibility to employment (A_j).

Step 2C: Add population growth to population totals and subtract some measure of available land utilized (either estimated or observed) by this growth from L_j .

The steps could be repeated for five-year intervals or for any other period where the exogenous predictions of overall growth in employment and population are available.

Other factors that contribute to the attractiveness of a location to employment or population could be added to the equation. These factors include land value, availability of infrastructure such as

water and sewer, and quality of life measures such as housing condition and crime. When adding other factors to the model, care should be taken to establish the relationships between the variables by assigning weights. Weighting can be achieved by using a regression model to determine the importance and significance of factors or by surveying stakeholders or local experts.

Policy considerations could be accounted for by modifying the available land variable (L_j) to take into account zoning, use, density, and conservation area restrictions. Calculating this variable would involve decisions or assumptions about environmental and physical constraints (wetlands, slope, brownfields) and may require use of GIS analysis to cull and sum up vacant parcels or portions of parcels in each zone.

Economic and Fiscal Impact Modeling/Cost-Benefit Analysis

The construction and operation of transportation facilities often result in direct economic and fiscal impacts. These direct impacts include the temporary increase in employment attributable to construction, the increase in business to local suppliers as construction materials are purchased, the increase in productivity as travel costs are reduced, and the loss of local property taxes resulting from the acquisition of right-of-way. There are other, indirect economic and fiscal impacts, however, that may be accounted for in the assessment of proposed transportation improvements. Examples of indirect impacts include:

- < The multiplier effect generated as direct expenditures on construction and maintenance materials increase demand for raw materials and intermediate products throughout the local and regional industry supply chain.
- < The multiplier effect generated as local construction and maintenance employees spend wages on consumer goods.
- < The direct and indirect impacts of the decline in economic activity as traditional business areas are bypassed by a new transportation facility.
- < The direct and indirect impacts of an increase in economic activity as new business are developed to serve the increase in traffic attributable to a transportation improvement.
- < The direct and indirect impacts of an increase in tourist activity resulting from gains in accessibility attributable to the transportation improvement.
- < The direct and indirect impacts of an increase in economic activity as other businesses are attracted to the area by gains in accessibility and productivity attributable to the transportation improvement.

- < The fiscal benefits (increase in property taxes) resulting from a rise in property values attributable to project induced growth.
- < The adverse fiscal impacts (increase government spending) resulting from the greater need for services (infrastructure, schooling, public safety) attributable to project induced growth.

Although it is generally possible under most circumstances to estimate the construction and maintenance impacts described above, it is often more difficult to quantify the economic/fiscal benefits and costs of project induced growth or increased accessibility. To the extent that project induced growth is quantified using other techniques in described in this chapter, however, it would be possible to use a common set of economic and fiscal impact tools to estimate these types of potential effects.

Because the direct and indirect economic impacts attributable to proposed transportation improvements are closely intertwined it will often be useful to analyze them simultaneously. There are four broad categories of direct and indirect impact measures to consider when evaluating project alternatives in a cost-benefit framework (TRB Circular 477, 1997):

- 1) *User Impacts* (value of each of the following measures may be combined to measure total impact)
 - money cost of travel
 - travel time
 - safety
 - comfort, reliability, etc.

User impacts are most often direct in nature, so they will not be covered in detail here. User impacts are best measured through transportation demand models.

- 2) *Economic Impacts* (each of the following measures is an alternative way to express total impacts, the measures are not additive)
 - employment
 - personal income
 - business sales volume
 - property values
 - value added
 - business profit

Economic impacts can be direct and indirect in nature. Direct impacts are attributable to spending on construction and maintenance itself. Indirect and induced impacts are attributable to project induced growth and the multiplier effects arising from direct spending.

Basic methods to measure direct and indirect economic impacts include:

Input/Output Models - These models rely on accounting tables (produced and updated on a five-year basis in the United States by the Bureau of Economic Analysis) that describe the linkages of inter-industry purchases and sales. With certain modifications, the data can be tailored to provide information applicable to a specific region. The models yield multipliers that show the full effect on all industries as final demand for the products produced by a proscribed set of industries (those involved in highway construction, for example) is increased or decreased. The multipliers allow for calculation of the direct, indirect, and induced output (sales), earnings (wages), and employment (full-time equivalent jobs) impacts. Models are commercially available from the Minnesota-based IMPLAN Group, the Regional Science Research Institute (PC I/O Model), the U.S. Bureau of Economic Analysis (RIMS-II) and many transportation planning consulting firms.

Macroeconomic Simulation Models - These models include the function of I/O models described above and additional features used to forecast the effects of future changes in business costs, prices, wages, taxes, productivity and other aspects of business competitiveness and shifts in population, employment, and housing value. As with I/O models, these methods can be used to evaluate the consequences of factors beyond travel costs impacts such as project induced growth, if the growth impacts are quantified with techniques exogenous to the model. Simulation models are available for rental, purchase, or custom studies. Examples include REMI (Regional Economic Models Inc.) and DRI-McGraw Hill.

Business Market and Tourism Attraction Studies - Specific factors unique to the study area can contribute to the attraction of businesses and tourists. Business factors such as proximity to suppliers, markets, and other modes of transportation, and tourist factors such as proximity to unique existing or proposed recreation, historical, or commercial amenities must be studied in detail to assess the potential for attraction that may improve with the accessibility attributable to the proposed transportation improvement.

- 3) *Government Fiscal Impacts* (value of each of the following measures may be combined to measure total impact)
- public revenues
 - public expenditures

Fiscal impacts arising from induced growth and land use changes attributable to transportation improvements can be calculated by using the analysis method described in this chapter for assessing induced growth combined with standard fiscal impact methodologies. Once the range of potential growth outcomes has been quantified, service standards describing the cost of providing additional infrastructure, education, emergency services, and other government functions can be applied to determine costs. The calculation of benefits must rely on assumptions based on the current profile of property taxes and ratables.

The recently developed SCALDS model (Social Cost of Alternative Land Development

Scenarios) available through FHWA provides a framework for applying the fiscal costs and benefits related to transportation improvements. The model is described in more detail under Integrated Transportation and Land Use Models below.

- 4) *Other Societal Impacts* (value of each of the following measures may be combined to measure total impact)
- air quality
 - impact to environmental features
 - change in societal conditions

Air quality impacts studies are most often limited to the direct impacts attributable to the proposed transportation improvement. The SCALDS model (described in more detail in Volume I, Appendix A) provides a framework for assessing air quality impacts related to induced development. Impacts to other features can be estimated using the other techniques described in each step of the indirect/cumulative effects analysis framework.

Integrated Land Use and Transportation Models

Transportation planners have long relied upon computer based models to predict how traffic patterns change with improvements to the transportation system. In the last two decades, there have been an increasing number of models that also predict the indirect land use effects of transportation projects—land development and the location of households and employers. To properly simulate the relationship between land use and transportation, integrated models are required. These models predict how changes in accessibility influence changes in location and how the congestion created by relocated households and businesses, in turn, affects accessibility. Several approaches have been employed to simulate locational decisions but it is the feedback between the transportation and land use components of these models that make them integrated and useful in the analysis of indirect/cumulative effects.

Since the early 1990s, computer modeling of land use patterns has become more sophisticated. In recent years, developers have undertaken improvements in the feedback loop between travel demand and land use components, have improved the process of calibration, and have added Geographic Information System software as a graphical interface for data input and output. Even the more complex computerized models now run quickly on standard desktop computers. This increased sophistication and improved usability has contributed to wider use of models at state agencies and MPOs.

A 1995 study described the results of a survey of model use at MPOs in the thirty-five largest metropolitan areas. Eighteen of the thirty-five employed or were planning to employ modeling techniques at the time of the survey: twelve indicated that they use one particular model (DRAM-EMPAL); another six have developed or are developing their own models. The remaining MPOs

employed qualitative techniques including the Delphi method to allocate forecasted population and employment. (Porter, 1995)

Land use and transportation models that are currently available for implementation are examined in detail in Volume I, Appendix A. In metropolitan areas where a state agency or MPO utilizes land use and transportation modeling techniques the analyst may wish to explore the possibility of utilizing the model to evaluate alternative future transportation and development scenarios.

Application of Analysis Techniques

The analysis techniques described above are applicable to a wide variety of systems planning and project evaluation circumstances. This section provides examples of how the methods discussed in this handbook can be combined to produce a complete analysis of indirect/cumulative effects. Examples are provided for analysis in the context of transportation systems planning and project evaluation under NEPA/SEPA.

There are several considerations involved in choosing appropriate analysis techniques to match project types and study area conditions. Figure IV-4 outlines factors related to the size, location, and characteristics of a project that could influence the level of effort and methodology.

There are three general steps necessary to analyze indirect/cumulative effects:

- < Assessment of the magnitude and location of development induced by a project should be the first step taken in the analysis, so that other effects may be analyzed in context..
- < The forecasts developed should include other activities in the study area that could impact notable features. Cumulative and indirect effects can be evaluated by comparing the Action and No-Action forecasts.
- < Encroachment alteration effects attributable to the project and the induced development may then also be evaluated in the context of the Action and No-Action forecasts.

Considerations important to carrying out each of these analysis steps are discussed below.

Figure IV-4
Factors to Consider When Matching Methodologies and Project Types

Project Variables		Implication for Assessment Methodology
Project Type	Roadway	Transit and large intermodal projects often require more complex, quantitative methodologies. Sketch qualitative measures may suffice for a small roadway widening but would be insufficient for a new highway.
	Transit	
	Major Intermodal	
Project Scale	Small	Smaller projects, as measured in budget or level of complexity, are more often analyzed with qualitative methods, while larger projects are amenable to more detailed quantitative approaches.
	Medium	
	Large	
Project Scope	Local	Regional projects would require more complex quantitative methods than local projects, system planning projects may be suited to qualitative or quantitative efforts based on setting and data available.
	Regional	
	System Planning	
Stage of Study	Corridor Alternatives	Although the broad-based nature of corridor studies may be suitable for qualitative measures, quantitative models may be better for analyzing impacts in a broad area. As alternatives are described in better detail, impacts must be analyzed more thoroughly and precisely.
	Alignment Alternatives	
	Project Design	
Project Setting	Degree of Urbanization	Projects in urban areas with low levels of growth may be analyzed with qualitative measures. Quantitative measures may be required in less urban areas such as suburbs or particularly the urban fringe with high levels of growth and environmental sensitivity. Rural settings where development pressure is thought to be low may require only sketch qualitative analysis.
	Level of Growth	
	Degree of Environmental Sensitivity	
Design Features	Level of Access Management	Projects with high levels of access controls (i.e. widely spaced interchanges) are likely to require a lower level of analysis since any induced development is likely to be focused at access points. Similarly, projects that do not provide additional capacity are unlikely to change accessibility and therefore require a lower level of analysis, that can be qualitative in nature.
	Amount of Capacity Added	
Project Purpose	Relieve Congestion	Projects designed only to relieve congestion may not need extensive analysis if they do not significantly change local or regional accessibility. Projects planned to serve existing development require a detailed assessment of the effects of that development. Projects intended to promote regional development must describe the nature and effects of that development.
	Serve Existing/Planned Development	
	Promote Regional Economic Development	
Data Available	Level of Quantification	Overall, the type of data available may have more influence on approach than other factors. Some of the more complex quantitative methods require detailed parcel level data in computer readable form, information not available in all cases.
	Level of Aggregation	
	Comprehensiveness	
	Currency	

Analyzing Induced Development

As discussed in Chapter 5, there are three types of induced development that must be considered. Application of analysis techniques to each of the three types of effects is discussed below.

Specific Development Proposals

Where transportation projects are designed to serve specific development proposals or economic development goals, the details of those projects or plans should be ascertained and documented as thoroughly as possible.

- < Planned or estimated levels of new housing units, and commercial/industrial space can be used to develop estimates of population and employment using the standard factors outlined in Figure IV-3. These factors may also be employed when only the acreage of proposed land uses are known.
- < The size and location of the development site and its individual elements should be documented where known so that conflicts with notable features may be evaluated.
- < Where the impacts described above have been documented as part of studies commissioned to evaluate the development proposal, the findings should be referenced, so that conflicts with notable features and community goals may be described.
- < Large development projects (especially those dedicated to a single office or residential use) may induce their own demand for development activity (residential, retail, and service activity to meet the demands of residents or employees of the new complex). Economic impact modeling, comparative case, or literature techniques may be employed to estimate the magnitude and location of this induced development.

Complementary Development

Factors contributing to the development of complementary land uses in the vicinity of proposed transportation projects (e.g., traffic volumes, distances to regional centers) and common patterns of that those uses take are outlined in Chapter 5. Once it has been determined that these elements are present at select interchange, intersection, or station locations, the likelihood and magnitude of the complementary development should be evaluated through the application of one or more of the following techniques.

- < Literature Review/Quantitative Analysis - Studies regarding commercial development at rural highway interchanges (see Hartgen & Kim, 1998; Hartgen, 1991) suggest minimum thresholds for traffic on connecting roads that would support various types of

complementary development (See Figure IV-5). Estimates for average daily traffic (ADT) on intersecting roads developed during the analysis of project purpose and need or derived from traffic counts or a travel demand model could be compared to these thresholds to determine the likely profile of complementary development at an interchange location under Action and No-Action conditions.

- < Comparative Case Analysis - An analyst could review development patterns at interchanges for projects and study areas with similar characteristics to determine the likely general profile for development patterns at interchange or station locations.
- < Scenario Writing - An analyst, using general data from the literature, comparative cases, or expert panel input could write scenarios representing the likely upper and lower bounds of complementary development at interchange or station locations under Action and No-Action conditions. Locations could be ranked based upon the criteria noted in Chapter 5 to evaluate whether a particular location would be likely to correspond to the higher or lower development scenario.

Once the nature of complementary development at various locations has been estimated the development scenarios can be evaluated for conflicts with notable features and community goals (see discussion of encroachment alteration effects below).

Intra-Regional Development Shifts

Analysis of intra-regional development shifts may be appropriate in the transportation systems planning context and the project evaluation context. Examples of technique application are outlined below.

Transportation Systems Planning - TEA-21 implicitly recognizes the importance of considering indirect and cumulative effects in the planning of transportation systems that takes place before the NEPA process. By considering the range of potential indirect and cumulative effects in the evaluation of mode and corridor alternatives the sponsoring agency can better evaluate the broad range of alternatives and lay the ground work for indirect and cumulative effects analysis required by NEPA/SEPA in the evaluation of project alignment and design alternatives.

The assessment of indirect/cumulative effects in the planning phase involves the following considerations:

FIGURE IV-5
CRITERIA FOR DEVELOPMENT SUITABILITY
AT RURAL INTERCHANGES

Motels:

Would have good prospects for development if the interchange:

- Is less than 1 mile from public water and sewer service.
- Has crossing road traffic volumes of 4,000 vehicles per day or more.
- Is less than 20 miles from the nearest intersecting Interstate Highway.

Gas Stations:

Would have good prospects for development if the interchange:

- Is less than 1 mile from public water and sewer service.
- Has crossing road traffic volumes of 10,000 vehicles per day or more.
- Is less than 1 mile from the nearest town.

Fair prospects if the interchange:

- Has crossing road traffic volumes of 5,000 vehicles per day or more.
- Is less than 3 miles from the nearest town.

Fast-Food Restaurants:

Would have good prospects for development if the interchange:

- Is less than 1 mile from public water and sewer service.
- Has crossing road traffic volumes of 7,000 vehicles per day or more.
- Is less than 20 miles from the nearest intersecting Interstate Highway. *Fair prospects if the interchange:*
- Has crossing road traffic volumes of 5,000 vehicles per day or more. Is less than 3 miles from the nearest town.

Sit-Down Restaurants:

Would have good prospects for development if the interchange:

- Is less than 1 mile from public water and sewer service.
- Has crossing road traffic volumes of 10,000 vehicles per day or more.
- Is less than 5 miles from the nearest intersecting Interstate Highway.

Residential Development:

Would have good prospects for development if the interchange:

- Has crossing road traffic volumes of *less than* 10,000 vehicles per day.
- Is less than 1 mile from the nearest town.

Fair prospects if the interchange:

- Has crossing road traffic volumes of *less than* 20,000 vehicles per day.
- Is less than 3 miles from the nearest town.

Low-density residential development in the vicinity of an interchange tends to become more likely if an interchange is near a town, and if there is less likelihood of commercial development. In other words, if conditions are suitable for commercial development, residential development is generally less likely to occur. Therefore, those interchanges which are the least suitable for commercial development are more suitable for residential, provided that there is a nearby town.

Source: Hartgen, et al., 1991

- < *Induced Growth* - Because details related to alternative selection and design are usually unknown in the planning phase, the focus of the assessment is on the potential for induced growth and related social and ecological effects. Where plans regarding access nodes (e.g., interchanges, stations) are known, consideration can be given to localized induced growth effects and encroachment-alteration effects on notable features.
- < *Link between Land Use Futures and Transportation* - In the planning of transportation systems, future demand for travel is an important consideration. This demand is related, in part, to anticipated growth in population or employment and land use decisions made by those groups. Although these variables are part of Travel Demand Modeling efforts used throughout many urbanized areas to evaluate plan alternatives, there must be specific feedback between transportation and land use systems to adequately evaluate indirect/cumulative effects. Very often a land use scenario is used to determine travel demand but the impact of a transportation system on land use decisions is not explored. This feedback loop is at the heart of induced growth analysis. Feedback is achieved by developing qualitative or quantitative land use scenarios based on the change in accessibility attributable to each planned alternative. Cumulative effects are addressed by incorporating other actions into the transportation and land use scenarios.
- < *Link between Land Use Futures and the Environment* - The final step in a complete indirect and cumulative effects evaluation at the planning stage is the linking of land use forecasts to notable features in the physical and natural environment. This is most easily accomplished using a cartographic overlay technique or GIS. These methods would allow for graphical representation of potential areas of conflict between the transportation system, anticipated planned and induced development and notable features in the environment in both the planned corridor and surrounding area. In determining the location of future growth and the potential for conflict with land use plans it is important to note a community's intention to adhere to a plan and its past history of granting rezoning and variance approvals that could alter land use plans.
- < *Revising and Updating Analyses* - Indirect and cumulative effects analyses conducted during the planning stage may serve as a good base for the analyses to be conducted in the evaluation of alignment and design impacts. Since significant periods of time often elapse from the evaluation of system plans to the environmental documentation for plan alternatives, however, care should be taken to re-evaluate assumptions in light of the time elapsed and greater knowledge of project details. Encroachment-alteration effects should also be explored as greater detail on project design is revealed. Sensitivity and risk analysis techniques (see Chapter 7) can be valuable tools in exploring the extent to which findings in a forecast change as assumptions change. Survey or expert panel techniques or a rerun of a forecast model could provide update to assumptions that may be required.

The methods described in this chapter can be combined in various ways to analyze indirect/cumulative effects in the planning phase. Options in methodology include but are not limited to the following examples.

Example 1:

- < Use survey of experts, consultation with local planners, or local/county comprehensive plans to develop base forecast of population, employment, and land uses for groupings of TAZs or other subregional level of analysis.
- < Use survey or panel consultation techniques to develop criteria for reallocation of population/employment/land uses to subregional areas in the vicinity of a transportation corridor to be improved. Reallocation should be considered for each plan alternative.
- < Map base and action alternative forecasts along with key environmental features drawn from existing secondary sources to reveal areas of potential social or ecological impact.
- < Using findings from mapping exercise, consultation techniques, and literature/comparative case review to write scenarios for base and alternative forecasts. Compare scenarios to each other and significance criteria to draw general conclusions about impacts.

Example 2:

- < Use a gravity model to allocate study area population and employment control totals to groupings of TAZs based on calculation of land available for development in each group and accessibility to other groups in the study area. Accessibility is calculated from zone-to-zone travel times produced by a Travel Demand Model (TDM) aggregated to the TAZ group level.
- < Repeat the gravity model exercise for each plan alternative with new accessibility factors derived from runs of the Travel Demand Model including the mode or corridor alternative.
- < Map base and action alternative forecasts derived from gravity model runs along with key environmental features drawn from existing secondary sources to reveal areas of potential social or ecological impact.
- < Using findings from mapping exercise, and supplementary consultation techniques, and literature/comparative case review to write scenarios for base and alternative forecasts. Compare scenarios to each other and significance criteria to draw general conclusions about impacts.

Example 3:

- < Employ an integrated Transportation-Land Use Model that uses TDM files for travel time input. The model will be run several times to examine each possible combination of transportation and policy alternatives. The model will be based on exogenously determined control totals and will be calibrated based on historical data and the professional judgement of agency analysts and local experts.
- < Model output can be mapped using standard cartographic or GIS techniques along with key environmental features drawn from existing secondary sources to reveal areas of potential social or ecological impact.
- < Using findings from mapping exercise, and supplementary consultation techniques, and literature/comparative case review to write scenarios for base and alternative forecasts. Compare scenarios to each other and significance criteria to draw general conclusions about impacts.

Project Evaluation - The methods employed in the analysis of project alternatives for NEPA are similar to those employed in the planning phase. Since project characteristics and circumstances are more refined however, the techniques, particularly the quantitative methods can be employed at a greater level of detail. Examples of how techniques can be combined to conduct analyses are given below for two possible scenarios—a scenario requiring basic techniques and one requiring a more detailed analysis. Tools should be tailored for the particular project circumstances, and level of information and resources available.

Example 1 - Basic Analysis Techniques:

The addition of an interchange to a limited access highway in a low-growth rural location is expected to have minimal potential for induced growth. To assess the induced growth potential and predict its magnitude the analyst would:

- < Use simple trend extrapolation techniques to produce baseline study area projections of population and employment for the 20-year assessment period. (This was necessary because the county planning office had not conducted forecasts for the area.) Analyst writes uses data to develop a “No Action Scenario” describing future conditions without the improvement.
- < Cite literature showing that interchanges in rural areas far removed from the urban core or employment centers are likely to induce only limited highway oriented development like service stations and convenience stores in quadrants nearest to oncoming traffic.

- < Cite the limited nature of development following a similar project in an adjacent county 10 years ago.
- < Write a scenario describing potential impacts from the conversion of a vacant parcel and several acres of nearby farmland to use by two gas stations, a convenience store, and a restaurant attracted to serve traffic using the new interchange. Analyst concludes that this scenario describes the lower boundary of reasonably foreseeable induced growth.
- < Write a scenario describing impacts arising from the construction of a large truck stop, a hotel, and several fast food restaurants. This scenario details the highest magnitude of growth that is reasonably foreseeable given assumptions established by the analyst.

Example 2 - Detailed Analysis Techniques:

A beltway in high-growth rural and suburban fringe location is anticipated to create opportunities for commercial and residential development involving the conversion of agricultural and forest land. To gauge the impact that the new facility will have on the pace and location of development in the study area the analyst would:

- < Develop a general No Action Scenario for the study area based on 20-year growth projections furnished by the local Metropolitan Planning Organization (MPO).
- < Use a gravity model to allocate study area population and employment control totals to TAZs based on calculation of land available for development in each zone and accessibility to other zones. Accessibility is calculated from zone-to-zone travel times produced by a Travel Demand Model (TDM) used previously by the MPO. At the end of the process the No Action Scenario is refined to describe future development on the TAZ level.
- < Repeat the gravity model analysis for every project alternative based on changes in zone-to-zone travel time produced by a TDM analysis of project alternatives conducted by the MPO previously to evaluate project feasibility.
- < Calculate land consumed in each TAZ by population and employment growth and maps the findings on the GIS maps created to show existing conditions. This analysis reveals potential areas of conflict with the natural environment (induced-growth related impacts) and current land use regulations.
- < Compare gravity model findings with surveys of local real estate development and land use professionals and other stakeholders.

- < Develop a scenario for project alternatives based on findings from quantitative and qualitative analyses.

Analysis of Encroachment Alteration Effects

Encroachment-alteration effects can be classified into three basic categories:

- < Effects related to characteristics of the proposed project (see Chapter 4 for characteristics; Chapter 5 for discussion of potential effects)
- < Effects related to other actions in the study area (incorporated into the baseline future or No-Action forecast scenario; see Chapter 4 for discussion of actions; Chapter 5 for discussion of potential effects)
- < Effects related to induced development (see Chapter 5 for a discussion of potential effects)

Regardless of the source, the general techniques for analyzing these effects are similar, and the magnitude, location, and likelihood of the effects from all sources should be evaluated in tandem. Techniques for analysis of encroachment alteration effects are, in general, similar to techniques used to evaluate the direct effects of proposed projects. Primary techniques for analysis include:

- < *Tables and Matrices* - While tables and matrices will not help the analyst quantify individual effects, presentation of encroachment-alteration effects in tabular or matrix format is helpful in organizing and summarizing quantitative and qualitative analyses. Measures derived from quantitative research or judgements derived from qualitative techniques may be summarized and compared in matrix format. A matrix is also particularly valuable in evaluating the cumulative effects of multiple actions on resources or categories of resources (CEQ, 1998). The forms of matrix notation (binary, quantitative, and weighted) are described in Chapter 5. A sample of a matrix developed to summarize the cumulative effects of a proposed action is presented in Figure IV-6. This table illustrates how direct impacts of a proposed action may be combined with indirect effects (encroachment-alteration effects and effects related to induced growth) and the cumulative effect of other past, present, and future actions to derive the a proposed action's cumulative effects on a variety of resource categories.
- < *Measures and Indicators* - Quantification or characterization of effects on individual resources can be accomplished through calculation of measures of performance or indicators of change suitable to particular resources. For example, the fiscal effects of induced residential growth can be described by showing the net change in government tax revenues and expenditures for services. The effects of induced growth on ground water can be evaluated by showing the change in gallons of water consumed per day, a reduction in aquifer recharge due to an increase in impervious surface, or levels of pollutants or nutrient

loading. Where precise quantification is not possible or not necessary to enable meaningful comparison between no-action and action alternatives then approximate ranges or high-medium-low characterizations can be employed. Examples of indicators appropriate to measure the effects related to land development are detailed in Figure III-18 in Chapter 5.

- < *Cartographic Techniques* - Successive layers of map overlays depicting notable features and areas where effects are anticipated can be very effective in evaluating and illustrating encroachment-alteration effects attributable to proposed actions or induced activity. Habitat and community fragmentation, land cover alteration and vegetation loss, coverage of community facility service areas, and effects on viewsheds and historic resources are particularly amenable to analysis through this technique. By adding maps depicting community plans and goals for land use and community facilities, the map overlay techniques can highlight areas of potential conflict between cumulative land use effects and community goals. Cartographic techniques are described in more detail in Chapter 5.
- < *Carrying Capacity Analysis* - This technique involves determining capacity of resource systems and the thresholds beyond which sustainability becomes threatened. Once these thresholds are determined cumulative effects to resources (calculated using the measures and indicators described above) can be more fully evaluated. This technique is particularly useful for evaluation of:
 - air quality and water quality/quantity;
 - wildlife populations;
 - infrastructure and community facilities; and
 - land use (through evaluation of density and uses permitted in districts and the likelihood change in future land use plans in response to development pressures).
- < *Models* - Models for calculating the propensity for change within resource systems are available and can be used in the analysis of indirect and cumulative effects where a quantitative approach to estimation has been employed. Use of models can be helpful particularly where models have been used in the evaluation of direct impacts and information quantitative information regarding indirect and cumulative effects can be readily added. Examples of models that may be employed include (CEQ, 1998):
 - air dispersion models;
 - hydrologic regime models;
 - soil erosion models;
 - sediment transport models;

- species habitat models; and
- regional economic models.

Modeling techniques can be combined with each of the other techniques described here to determine carrying capacity and impact measures, or input for matrices or map layers.

Work Product of Step 6

The findings of the indirect and cumulative effects analysis must be documented along with a discussion of the methods employed, why they were selected, and how they were used. The work product of this step can take the form of a technical memorandum. Figure IV-6 provides a framework for summarizing a wide-range of direct and indirect effects that may be adapted for particular analyses.

FIGURE IV-6
SUMMARY OF DIRECT, INDIRECT, AND CUMULATIVE EFFECTS

Impact Type	No-Action Future Conditions <i>(Conditions without the Proposed Action)</i>		Impacts of the Proposed Action <i>(Incremental Effect of the Proposed Action)</i>			Cumulative Effect <i>(Future Conditions with the Proposed Action)</i>
	Other Past/Present Actions	Other Future Actions	Direct Impacts	Indirect Effects		
				Encroachment-Alteration Effects	Effects Related to Induced Growth	
Habitat Fragmentation/Degradation						
Ecosystem Disruption						
Natural Process Disruption						
Air Quality						
Water Quality						
Noise						
Community Cohesion/Stability						
Alteration of Travel Patterns						
Quality of Life Effects						
Historic Resources						
Aesthetic Effects						
Other						
KEY: * low adverse effect ** moderate adverse effect *** high adverse effect + beneficial effect [] no effect						

Resources and Supplementary Readings

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Chapter 7

Step 7 - Evaluate Analysis Results

Overview

Assessing the magnitude of indirect/cumulative effects, the goal of the previous step, involved making several types of assumptions regarding:

- < the nature of the impact-causing activities;
- < the nature of the cause-effect relationships; and
- < how the environment will be affected by the impacts.

The objective of this step is to evaluate these assumptions and the uncertainty they produced so as to better understand the indirect/cumulative effects. The product of this step should be thorough documentation of any uncertainty and how that uncertainty may influence the range of indirect and cumulative effects.

This chapter will:

- < describe the issues involved in evaluating analysis results;
- < outline a basic technique for analysis evaluation;
- < provide criteria to be used in assessing the need for more detailed evaluation techniques; and
- < discuss more detailed evaluation techniques including:
 - sensitivity analysis, and
 - risk assessment.

Considerations

The purpose of the framework to this point has been to outline techniques and procedures for identifying and estimating indirect/cumulative effects of proposed transportation projects. The goal of these tasks has been to produce an assessment suitable for informing the decision-making process and the evaluation of alternatives. There is inherent uncertainty in estimating indirect/cumulative effects, however, and a risk that the actual outcome will differ from that forecasted. Information regarding the level of uncertainty in an estimate of indirect/cumulative effects should, therefore, be communicated to decision makers and the public for consideration along with the results of the analysis. Similarly, information regarding differences of opinion among stakeholders and experts consulted with respect to forecasted outcomes should also be disclosed. Included in this disclosure should be discussion of differences on goals, notable features, indirect and cumulative effects meriting analysis, and analysis techniques and results. The basic and detailed methods involved in undertaking this evaluation are discussed below.

Basic Technique for Analysis Evaluation

In circumstances where either substantial indirect and cumulative effects have been found or where no such effects have been found, it may not necessary to apply some of the more detailed sensitivity or risk analysis techniques described below, even if detailed techniques have been used in other steps in the framework. The key criteria in assessing the need for detailed evaluation are:

- < whether the analysts or stakeholders believe that there is any level of uncertainty regarding the underlying assumptions used to estimate the indirect and cumulative effects,
- and*
- < whether changes in the underlying assumptions can be expected to result in significant changes in the findings.

If uncertainty in the underlying assumptions is recognized but variation in the assumptions is unlikely to significantly alter the findings then the uncertainty and conclusions regarding sensitivity should be carefully documented and the analyst may proceed to the final step in the framework.

If analysts or stakeholders see a level of uncertainty in the assumptions employed and that uncertainty is likely to significantly alter the findings then a more detailed evaluation is warranted.

Detailed Techniques for Analysis Evaluation

There are two key techniques that are of use in evaluating indirect/cumulative effects analyses:

- < *Sensitivity Analysis* - This procedure involves changing forecast assumptions one at a time to test the sensitivity of effects to the particular assumptions. In other words, the purpose of this analysis is to test whether slight shifts in the analytical assumptions would cause larger changes in the effect, and help clarify degrees of confidence in estimating effects. This technique is applicable to both qualitative and quantitative assessments. Where multiple scenarios for the same project or no action alternative have been developed (i.e., best and worst case), sensitivity of impacts to changes in assumptions is known and this step need not be repeated.

There are several disadvantages to this method of evaluation.(Lewis, 1995):

- Assumptions and judgements are often varied by arbitrary amounts instead of by reference to reasoned analysis of potential error. To avoid this, an attempt should be made to construct reasonable alternative scenarios.
 - The what-if assumptions or scenarios used in sensitivity analysis do not identify the probability of alternative outcomes. This is overcome by utilizing risk assessment techniques (see below).
 - Worst-case scenarios often assume the highly unlikely event that all assumptions will deviate from expectations in the same direction, providing less information to the analyst than a more probable scenario.
- < *Risk Analysis* - This method includes a family of forecasting techniques and planning processes used to examine risk and uncertainty in alternative courses of action. It is best performed when quantitative methods have been used. Risk analysis seeks to improve the quality of information available for decision-making by revealing and clarifying the implications of uncertainty in technical and analytical decision-support material. There is no presumption of best or most accurate forecast; rather, the whole range of conceivable outcomes is arrayed together with the estimated probability of each occurring. Combined with group-oriented public involvement methods, e.g., a collaborative task force of stakeholders, risk analysis can promote consensus. In this way, it can bridge gaps between the forecasting level and the policy level.

Risk Analysis involves the following steps:

- *Identify variables and causal factors* - this step has been performed in the identification and analysis of indirect/cumulative effects.
- *Elicit expert/stakeholder opinion on the uncertainty of variable and causal factors* - variables should be restated in ranges to reflect uncertainty, these ranges correspond to probability distributions. This step is best completed with the assistance of spreadsheet-based risk analysis software (@RISK by Palisade Corporation is one example).
- *Report results* - risk analysis software will take a quantitative model and find the most likely outcome based on the probability distributions of the variables. Each output variable will be stated as a probability distribution indicating the range in which it could be expected to vary and the probabilities of those alternative outcomes.

Once the level of uncertainty in assumptions and outcomes has been properly explored and documented the analyst may move on to assessing consequences of indirect and cumulative effects and discussing options for mitigation.

Resources and Supplementary Readings

Lewis, D., 1995, "The Future of Forecasting: Risk Analysis as a Philosophy of Transportation Planning," TR News, No. 177, March-April, pp 3-9.

@Risk, spreadsheet software risk analysis tool, Palisade Corporation, www.palisade.com

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SECTION V
ASSESSING THE CONSEQUENCES

SECTION V

ASSESSING THE CONSEQUENCES

The purpose of estimating indirect/cumulative effects of proposed transportation projects is to contribute to the body of information that will support a decision about whether

- < to proceed with the plan or project, as proposed;
- < to formulate a revised plan or project; or
- < to otherwise mitigate adverse indirect/cumulative effects associated with the proposed plan or project.

The objective of this step is to assess the consequences of the analyzed indirect/cumulative effects and develop strategies to address unacceptable indirect/cumulative effects.

The analysis of indirect and cumulative effects involves the following step of the framework:

- < Step 8 - Assess the Consequences and Develop Appropriate Mitigation and Enhancement Strategies

This step and the methodologies appropriate for carrying it out are described in detail in Chapter 8.

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Chapter 8

Step 8 - Assess the Consequences and Develop Appropriate Mitigation and Enhancement Strategies

Overview

Once the full range of indirect/cumulative effects have been identified and evaluated it becomes important assess the consequences of effects and determine the need for modifications to avoid effects, or strategies to mitigate effects.

This chapter will:

- < outline the considerations involved in assessing consequences, determining the need for mitigation, and developing a mitigation plan;
- < provide an illustration of the mitigation decision-making process; and
- < identify indirect/cumulative effects mitigation techniques that can be used by the sponsoring agency or recommended to outside agencies, as appropriate.

Considerations

When assessing the consequences of an indirect/cumulative effects analysis and the need for mitigation or enhancement measures, there are several major considerations:

- < Does the analysis of effects provide a reasonable basis for informed decision-making?
- < Are there significant effects that are seen as unacceptable?
- < Are there practicable mitigation/enhancement measures?
- < Are mitigation/enhancement measures within the jurisdiction of the sponsoring agency?
- < What is the sponsoring agency's role when mitigation/enhancement measures are not within its jurisdiction?

These considerations are discussed in detail below.

Providing the Basis for Informed Decision Making

Uncertainty can lead to controversy regarding indirect/cumulative effects. There is an obligation to ensure that the descriptions and analysis in the indirect/cumulative effects analysis are reasonable and accurate. One of the tests for reasonableness deals with the resolution of controversy. Should the question (e.g., degree of impact, likelihood of impact) have two sides, each with reasonable arguments, then the agency NCDOT obligation is to reveal both sides of the matter and, using NCDOT or outside agency, choose between the sides. The key is to disclose the controversy and to make a reasonable choice on the impacts.

The review of case law discussed in Volume I indicates a requirement that mitigation of effects (direct, indirect, and cumulative) must be discussed in an EIS “in sufficient detail to ensure that environmental effects have been fairly evaluated” (Robertson v. Methow Valley Citizens Council, 490 U.S., 332, 252 (1989)). The EIS must describe mitigation that could be undertaken by either the agency itself or by other entities over which the agency has no control. However, the agency is not required to implement any of the mitigation ideas itself, or to receive implementation commitments from other entities.

Determining When a Potential Impact May Be Considered Unacceptable

Guidance for determining what is unacceptable can be found in the initial steps of the indirect/cumulative effects assessment process, i.e., the goals and notable features identification (see Step 2 - Chapter 2). If the analysis indicates that the proposed project could produce effects that would conflict, delay, or interfere with a study area goal identified in Step 2, then the proposed project, or the activity of the project responsible for that effect, is potentially unacceptable. Step 2 also suggests that the goals identification process attach relative importance to each relevant goal. Effects that would conflict, delay or interfere with relatively important goals should be considered significant in the local context.

Relative importance is also helpful for dealing with uncertainty. Experience indicates that if something of extreme importance could be affected through a chain of causality linked to a proposed project, then there will likely be reaction to the effect regardless of the degree of uncertainty about whether the effect will really occur. As one commentator notes, “Whether a specific use of the land in reality causes any economic or social problems may not be as important as what people perceive the problem to be.” (Loundsbury, 1981) The message for indirect/cumulative effects assessment is that the goals identification should not be treated lightly, as it lays the foundation and context for the entire assessment.

Mitigation for Impacts to Notable Features

Depending on the project circumstances, mitigation of indirect/cumulative effects on notable features may also require consideration. It is suggested that such consideration occur when one or more of the following circumstances exist:

- < The effect could worsen the condition of a notable feature considered sensitive or vulnerable.
- < The effect could interfere with or delay the planned or required improvement of a notable feature.
- < The effect could eliminate a notable feature that is valued or unique, or render the valued or unique feature ordinary.
- < The effect is otherwise inconsistent with an applicable law.

Determining the Practicability of Mitigation

As with mitigation of direct effects, mitigation of indirect/cumulative effects is not always practicable. The U.S. EPA's Section 404(b)(1) Guidelines (40 CFR 230) provide a definition of the term "practicable" with respect to project alternatives as available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes. These considerations should be part of the evaluation of alternatives to avoid or minimize an indirect effect, or other form of mitigation.

Responsibility for Mitigation and the Role of the Sponsoring Agency

The essence of the responsibility issue is whether the indirect effect is within or outside the control of the sponsoring agency. This issue was a subject of debate in the U.S. EPA's promulgation of its "General Conformity Rules" (FR 63214-63259). These rules require that federal agencies make determinations that each of their agency's federal actions conform to the state implementation plan for attaining and maintaining air quality standards. In developing the rules, many federal agencies stated that it is unreasonable to withhold a conformity determination where it is impracticable for the federal agency to remedy the situation. The U.S. EPA concluded that it would be unreasonable to interpret the Clean Air Act as requiring federal agencies to take responsibility for emissions that they cannot practicably control and for which they have no continuing program responsibility.

The U.S. EPA used the Supreme Court's analysis in its 1989 decision in *Robertson v. Methow Valley Citizens Council* (409 U.S., 109 S.Ct. (1989)) to support this conclusion (see 4.0 Case Law, Volume I, Section I). In that case, which involved the Forest Service's issuance of a special-use permit to a private developer, the imposition of the mitigation plan was within the jurisdiction of state and local agencies not the sponsoring agency. The court held that: "it would be incongruous to conclude that the Forest Service has no power to act [on issuing the permit] until the local agencies have reached a final conclusion on what mitigation measures they consider necessary."

However, the court added that the federal agency in such circumstances does need to advise the state and local agencies with mitigation authority as to what it considered appropriate mitigation. This advice is considered part of the federal agency's NEPA responsibility.

Mitigation responsibility for indirect/cumulative effects of transportation projects proposed by NCDOT is based on the distinction between those effects that are within the control of the project agency and those that are outside the control of NCDOT, to the extent that such distinction is consistent with federal and state laws. The typology for distinguishing indirect/cumulative effects outlined in Volume I is consistent with this approach. Specifically, "encroachment-alteration" effects can be equated to "within the control" of NCDOT, while "induced growth and effects related to induced growth" are generally "outside the control" of NCDOT (the exception being to avoid or minimize impacts through change in access location, where practicable). Indeed, the U.S. EPA used airport expansion and adjacent development of an industrial park as an illustrative example of federal control within the preamble to its "General Conformity" rule. In the example, development of the industrial park is known to depend on FAA approval of the airport expansion. Under the Framework, the airport expansion is a project that "would likely stimulate land development having complementary functions." For purposes of Clean Air Act conformity, the example notes that the FAA is responsible for emissions from airport-related activities but is not responsible for emissions from the industrial park. Within the context of the indirect assessment framework, however, the FAA would be responsible for analyzing the industrial park and its effects and recommending mitigation if such effects would be unacceptable.

Among those indirect/cumulative effects generally within the control of NCDOT are:

- < Generally, those indirect/cumulative effects associated with the location of the project and its access provisions;
- < Effects related to how the project is constructed, e.g., modification of regime, land transformation and construction, land alteration, resource extraction, etc.; and
- < Effects related to how the project right-of-way will be used and maintained, e.g., traffic and traffic-related effects, fertilization, chemical deicing, weed control, pest control, etc.

Methods

The primary method for assessing consequences and developing mitigation consists of a set of steps where each identified indirect effect is evaluated in the context of the overall aim of the project and study area goals and notable features. This process and the steps of the indirect/cumulative effects assessment framework leading up to it are illustrated in Figure V-I.

An effect that would adversely impact a study area goal or notable feature may require mitigation. If a mitigation effort is impractical, NCDOT should fully document the reasons for the impracticability of mitigation.

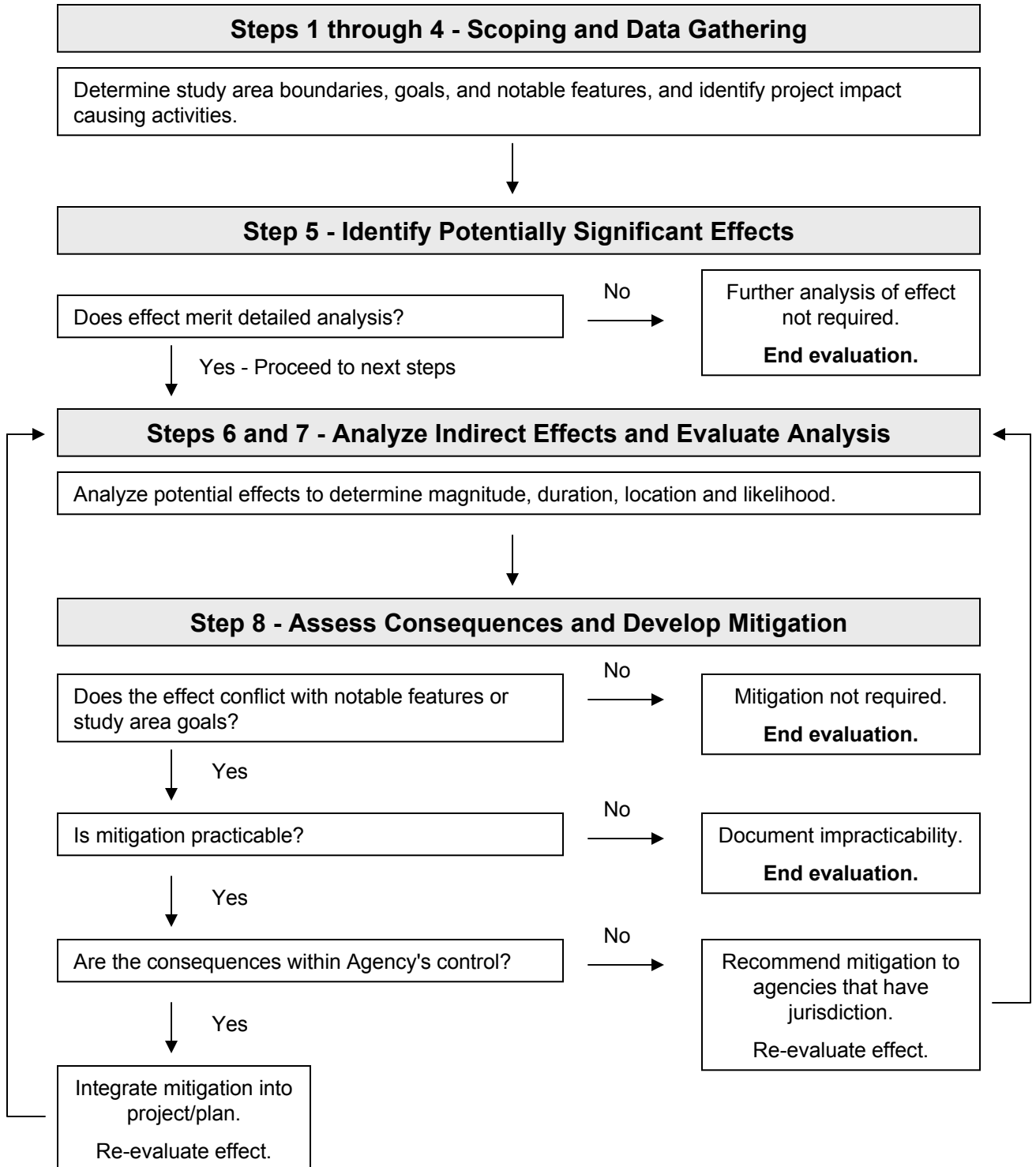
If practical mitigation alternatives do exist, NCDOT determines whether such efforts are within its control or jurisdiction. For example, many mitigation efforts relevant to induced growth and its consequences are within the control of municipal and county agencies, not NCDOT. In these cases, it is the responsibility of NCDOT to identify and assess potential effects, recommend strategies for mitigation, and re-evaluate the extent of the effect if such mitigation efforts were implemented.

If mitigation strategies are within the jurisdiction of NCDOT should document its mitigation plan and how such mitigation efforts are expected to ameliorate adverse indirect/cumulative effects.

Potential mitigation techniques relevant to the major categories of indirect/cumulative effects and example applications of those techniques are outlined below.

Figure V-1

**Indirect Effects Evaluation Framework and
Process for Assessing Effect Consequences and
Developing Mitigation/Enhancement Strategies**



Mitigation Techniques for Encroachment-Alteration Effects

Encroachment-alteration indirect/cumulative effects, although often distant in time and space from the project, are similar to many direct project effects and can be addressed with similar mitigation strategies. As with direct effects, in many cases these strategies involve altering one of the following aspects of the project or plan within the control of the NCDOT:

- < Facility type
- < Facility alignment
- < Facility design features
- < Techniques used during construction
- < Facility maintenance

Mitigation Techniques for Induced Growth

The three broad types of project induced growth can be mitigated to some extent through a variety of access control by NCDOT or land use control techniques by local municipalities. These techniques are described below as they relate to the primary types of induced growth. It should be noted that not all regulatory techniques are available for use in all jurisdictions due to the structure of local land use laws.

Techniques Available to the NCDOT

There is one primary technique in which NCDOT can work under its own authority and initiative with local government to influence the magnitude and location of induced growth activity:

- < *Access Management* - The extent and location of complementary development and regional development shifts can be controlled to some extent through modifications to the access plan for the facility. For highway facilities, aspects of the project that can be modified include the location of interchanges, the type of the interchange (partial, one-way access or full access), connectivity to local arterials, traffic patterns on connecting roadways, the presence of frontage roads, and curb-cut regulations on connecting roadways. For transit facilities the location of stations, and the type of service, and frequency of stops can be modified. Some of these features such as the type and location of interchanges are within the jurisdiction of the sponsoring agency. Other issues, such as traffic patterns and curb-cut regulations may be within the jurisdiction of local agencies.

Techniques Available to Other Entities

Several techniques for regulating and managing growth induced by a proposed project or other actions are available for implementation by local governments and other agencies. Where induced growth has been determined to be an issue requiring mitigation, the EIS must describe techniques for growth management that may be implemented by other parties. These techniques fall into the following general categories:

- < *Zoning/Comprehensive Planning* - Local zoning controls and comprehensive planning are outside the jurisdiction of the NCDOT but are often the most effective tools at controlling induced growth. Zoning involves the regulation of both the density and use to which land may be put. When combined with comprehensive planning, zoning allows communities to shape patterns of growth and development within their boundaries.

To use zoning and planning effectively as a tool to mitigate project induced growth, the land planning process should ideally run concurrent with the transportation planning process. If the land planning process occurs at a later time, particularly in areas in that are clearly in the path of future development, anticipation of the project among developers and land holders may make the planning process more difficult. NCDOT can play a role in this process by encouraging local agencies to consider transportation facilities in land use planning through early consultation and coordination with local governments throughout the planning and environmental review process.

A zoning response to a transportation plan or project is also most effective when it involves an area-wide or region-wide approach to distinguishing areas suitable for growth from those requiring conservation. In circumstances where numerous planning jurisdictions are present in the impact area the involvement of NCDOT or another regional planning agency may be necessary to produce a coordinated response.

In cooperative efforts with local governments and agencies it should be noted that zoning regulations enacted as a response to the induced growth effects of transportation facilities should balance other needs of the community including employment and housing for all income groups.

- < *Growth Management Regulation*- Several jurisdictions have pursued regulatory strategies that allow for regulation of the timing and location of residential and commercial development in a manner not addressed by traditional zoning regulations. Examples of growth management techniques that may be suggested for implementation in North Carolina include the following.
 - Adequate Public Facilities Ordinances (APFOs) - This type of growth management strategy links approval for certain types of projects (those requiring subdivisions or

variances, for example) to a review of the capacity of infrastructure to serve those projects. Infrastructure types often considered in these ordinances include water/sewer service, local transportation facilities, and other government services. Long range plans for the programming of infrastructure projects in Capital Improvement Plans are prepared as part of the ordinance and projects exceeding the capacity of infrastructure before improvements will be in place do not receive approval. Conditional approval of subdivisions based on provision of infrastructure at the developers expense (exactions) is provided for under North Carolina law but ordinarily limited to streets, utilities, and parks, and does not cover schools, fire stations, or other community facilities. Requirements for the dedication of land (for purposes other than parks or utility easements) or the payment of impact fees is not expressly provided for under North Carolina law. (Lawrence & Wicker, 1996).

- Development Moratoria - Similar to APFOs, moratoria give local jurisdictions the authority to halt new development projects until public facilities are improved to an appropriate level. Moratoria have also been used to preserve corridors slated for transportation improvements.
- Urban Growth Boundaries - Some metropolitan regions outside of North Carolina have adopted growth boundaries surrounding metropolitan areas to preserve open space around cities, slow the growth of suburban sprawl, and focus development into urban cores where infrastructure levels provide capacity for growth. These growth boundaries are often designed to accommodate growth projected for twenty to thirty-year periods. Growth boundaries are effectuated by strictly regulating densities outside the growth boundaries or limiting the provision of infrastructure beyond the boundary (planning techniques that are permissible under North Carolina law). Regional authorities are often given the responsibility of regulating and planning the growth boundary system. Formal regional management of growth beyond county boundaries would likely require special enabling legislation in North Carolina. Portland, Oregon's experience shows that growth boundaries can be successful in preserving green space and promoting development of the core, but regulations need to be reviewed frequently to prevent spillover growth just outside protected areas.
- Extraterritorial Zoning/Annexation - In some fast growing metropolitan regions, cities are given special authority over zoning issues and development applications in unincorporated areas outside city limits. Annexation and extraterritorial zoning powers are provided for under North Carolina statute. (Lawrence & Wicker, 1996). This authority is meant to promote the orderly growth of the metropolitan area and compatibility between the city center and the periphery. Extraterritorial zoning authority is also granted with the expectation that city boundaries will eventually expand to keep pace with urban development. Policies meant to ease the process of annexation of incorporated or unincorporated suburban or fringe lands into a city's

jurisdiction can mitigate against the induced growth impacts of transportation improvements by allowing planning, zoning, and growth management strategies to be implemented on a regional basis.

Mitigation Techniques for Effects Related to Induced Growth

In addition to managing residential and commercial growth induced by a transportation project, a local jurisdiction may also choose among strategies designed to mitigate the environmental and social effects related to induced growth.

Techniques Available to NCDOT

- < *Context Sensitive Design* - A major goal of context-sensitive design is to allow for local public input early in the design process so that costly delays and revisions can be avoided. Examples of context sensitive design and flexible standards include, deviation from the standard length of an acceleration or deceleration lane to protect a notable feature, modifying the design of an arterial that passes through a downtown area to allow for a boulevard that would better fit with the local context, and inclusion of special materials or design features to allow the facility to fit the scale and style of its surroundings.

Techniques Available to Other Entities

- < *Resource Management and Preservation Regulations* - Specific regulations designed to protect vital resources can work to guide the path and intensity of development and limit impacts on notable features related to induced growth. There are several examples of implementation of resource management in North Carolina. General categories include:
 - Coastal areas where development areas are delineated and development is permitted only under special circumstances in critical areas.
 - Stream buffers where development is regulated to protect the quality and quantity of water resources, prevent flooding, and promote water-related tourism and recreation.
- < *Performance Standards* - North Carolina law makes provision for the use of performance standards in local zoning and subdivision regulations. Performance standards can define uses as-of-right or the standards required for obtaining a conditional use permit. Performance standards encompass the following types of regulation.
 - Regulation of height, bulk, setback, lot size and other dimensional features.
 - Regulation of uses within zones and standards that define and distinguish uses.

- Specification of site design features such as off-street parking, impervious surface, vegetative cover removal, landscaping and screening, signage.
 - Specifications of standards for noise and pollutant emissions allowed in manufacturing or agricultural activities.
 - Standards for community appearance or historic preservation with review and limited enforcement powers vested in a planning agency or special commission.
- < *Land Acquisition/Conservation Easements* - A technique for preservation of green space, habitat, or other important resource areas that is seeing increasing use is the acquisition of land or development rights by government agencies, non-profit groups, or other private initiatives. These groups purchase or accept donations of land and pledge to keep the land permanently undeveloped. Development rights can also be purchased while the underlying title and use is retained by a landholder through the use of conservation easements. These easements once written into the a deed can permanently prevent development on a parcel regardless of future ownership. Carefully planned acquisitions can work to focus growth and protect notable features from growth related impacts.

Techniques for the Systems Planning Stage

Many of the techniques outlined above are applicable to the transportation systems planning as well as to project development. As noted above, comprehensive planning, resource preservation regulations, and other techniques meant to shape growth, when integrated with the planning of transportation systems will minimize the likelihood of indirect/cumulative effects on notable features and conflicts with community goals. There are some additional techniques applicable to transportation systems planning that may be useful, however.

- < *Comprehensive Performance Measures* - Traditionally in the planning of transportation systems, the assessment of need for a transportation project has been based in part on measures of mobility in the existing transportation system. These measures focus on the efficient movement of vehicles. This is often measured in level of service (LOS) ratings describing various states of traffic conditions. Mobility measures provide no linkage, however, with land use conditions in the vicinity of projects. This disconnect can lead to the potential for conflict with notable features or goals later in the process. Evaluating projects with performance measures related to accessibility will help better connect transportation needs, land use considerations, and concerns regarding sustainability. Such measures include:

- Vehicle Miles Traveled (VMT) or Vehicle Hours Traveled (VHT)
- Accessibility to jobs and commercial centers
- Impact on Jobs/Housing Balance

The use of integrated transportation and land use models that employ a feedback loop between transportation and land use choices will also help integrate evaluation of induced growth concerns into the systems planning process.

- < *Promoting Regional Coordination* - As discussed throughout this handbook, early coordination on a regional level is the best method for evaluation and mitigation of indirect/cumulative effects. Regional coordination is especially important in controlling induced growth because a variety of uncoordinated local regulatory responses may work to intensify effects in the least regulated areas.

Work Product of Step 8

The product of assessing the consequences and developing mitigation should consist of documentation: the comparison of indirect/cumulative effects to the relevant goals and notable features (i.e., the assessment of consequences); the mitigation strategy developed to address any unacceptable indirect/cumulative effect; or mitigation considered and reasons why mitigation is not practicable. The documentation should note what the mitigation entails, its anticipated effectiveness, how it should be implemented, and who is responsible for implementation. It should also be shared with those having a stakeholder interest in the studied effect and mitigation, as well as those responsible for ultimately implementing the mitigation, if responsibility lies outside NCDOT's purview. Completion of this last step in the indirect/cumulative effects assessment process will allow for full documentation of the process in a transportation plan or project environmental documentation.

Resources and Supplemental Readings

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APPENDIX A
SAMPLE SURVEY INSTRUMENT

Appendix A
Sample Survey Instrument

PURPOSE

The purpose for implementing the Potential Development Questionnaire is to gain insight from local and regional professionals into the study area's economic and development patterns in order to assess how future economic and physical development patterns will be affected by the Project.

Interviewee: _____

Title: _____

Affiliation/ Company: _____

Phone Number: _____

INFRASTRUCTURE & DEVELOPMENT

1. Please list what you perceive to be the potential significant development projects in the study area that will be constructed by the Year 2025 using the attached table. Additionally, please indicate how each projects' probability of development increases or decreases due to the completion of each section of the Northern Beltway. This list should include projects under construction, pending approval and other proposals you believe will have a reasonable chance of being constructed by the Year 2025.

2. Do you think that the study area's current zoning and land use plans sufficiently address future development needs and transportation improvements? If no, please explain what zoning and/or land use plans you think are necessary.

___Yes ___No

3. What issues and concerns regarding land use and transportation infrastructure development in the study area do you perceive as most important in the region? Additionally, do you interpret these issues and concerns as being sufficiently addressed in the comprehensive plans? Please specify.

4. Do you anticipate that there will be a future land use and development pattern scenario with the Project that differs from the future scenario without the Project? If yes, please describe below and indicate areas that may be affected on the attached Map #1.

___Yes ___No

Appendix A
Sample Survey Instrument

5. We would like to determine the potential for zoning changes or infrastructure changes in the event that the Project is implemented. In your opinion, would the Project affect the future zoning or infrastructure plans in the study area?

☐ Yes ☐ No (If No, please skip to Question 7)

6. In your opinion, what areas of the study area, if any, would be first targeted for rezoning in order to accommodate future demand and need? Please indicate on attached Map #2. What types of changes (i.e., density or use type)?

7. Do you anticipate that the Project will promote additional capital investments to support future development that otherwise would not be made? Please explain and identify on Map #3 the areas and type of infrastructure improvement (i.e., water, sewer)

☐ Yes ☐ No

8. Would you anticipate that the Project will affect the demand for available development parcels or planned/proposed development projects?

☐ Yes ☐ No

9. If you answered Yes to Question 8, what is the likelihood of the Project influencing timing or status of planned development projects?

☐ High ☐ Low

Appendix A
Sample Survey Instrument

COMPETITIVE STRATEGIES AND ACCESSIBILITY

10. How do you see the First Phase of the Project influencing traffic and transportation patterns and what industries and/or populations will it most affect, and in what way?

11. How do you see the Second Phase of the Project influencing traffic and transportation patterns and what industries and/or populations will it most affect, and in what way?

12. What types of industries and business will be most affected by construction of the:

First Phase

Second Phase

13. What are some of the competitive strengths that the study area has over other counties in North Carolina? What are some of the weaknesses? (i.e., in terms of technology, the labor pool, industrial base, etc.)

Strengths:

Weaknesses:

Appendix A
Sample Survey Instrument

14. How significant a role does transportation and accessibility play in residential, commercial and industrial development in the study area?

15. Do you think that either or both Project Phases will improve travel time and reliability in the study area? If yes, what impacts would you anticipate this improvement would generate?

16. How do you think the study area will respond to current and predicted national and regional changes in industrial and commercial trends? What additional support, suppliers, etc. will these industries need?

17. How does access to the study area affect its competitive advantages in relation to other North Carolina cities?

18. In your opinion, how will industry and business trends in the study area change by 2025 if
a) the First Phase of the Project is not built? b) the Second Phase of the Project is not built?
and c) no significant improvements are made to the roadway network?

a)

b)

Appendix A
Sample Survey Instrument

c)

19. What other persons do you recommend we contact to receive informed opinions regarding the economical and development impacts of the Project?

Person

Affiliation

Contact Information